



Deval L. Patrick, Governor
Richard A. Davey, Secretary & CEO
Frank DePaola, Administrator



604428 – 14

SEPTEMBER 9, 2014

ADDENDUM NO. 3

To Prospective Bidders and Others on:

CHELSEA

**Construction of the Silverline Gateway Busway,
BRT Stations and Bridge Replacement (Steel) Br. No. C-09-001
Washington Avenue over the MBTA Railroad**

BIDS TO BE OPENED AND READ: TUESDAY, SEPTEMBER 16, 2014 at 2:00 P.M.

Transmitting changes to the Contract Documents as follows:

RESPONSE TO CONTRACTOR QUESTIONS

11 Pages Attached

DOCUMENT 00102

Revised Page 1

DOCUMENT 00715

Replaced Document

DOCUMENT A00801

Revised Pages 7, 8, 20, 23, 122, 123, 125, 153, and 166.

DOCUMENT A00803

Inserted Pages 7.1 to 7.20, 71.1 to 71.8, 114.1, 114.2, 135.1 to 135.60, 232.1 to 232.4, 302.1 & 302.2
Revised Pages 3, 4, 8, 11 to 20, 114, 131 to 136, 145, 148, 179, 180, 184 to 188, 205 207 to 210, 219, 221, 231 to 245

DOCUMENT A00804

Insert pages 2.1, 2.2; Revised Pages 6 to 15, 61, 63

DOCUMENT B00420

Revised Pages 20 & 21

DRAWING REVISIONS

Revised Sheets 6, 14, 15, 24, 26, 27, 36, 38, 72, 74, 75, 86, 101, 102, 133, 136, 137, 201, 202, 208, 209, 212, 213, 214, 217, 218, and 219 of 346

Please take note of the above, substitute the revised pages for the originals, insert the new pages, and acknowledge Addendum No. 3 in your Expedite Proposal file before submitting your bid.

Very truly yours,

Frank Kucharski, P.E.
Construction Contracts Engineer

Jb & J. Pavaio, Project Manager

CHELSEA

**Construction of the Silverline Gateway Busway,
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Question from The Middlesex Corporation Dated 09/03/2014 @ 9:15 AM:

Question 9) John von Goeler at Scheidt & Bachmann USA Inc. provided me with your contact info. We are bidding this project on 9/16 and see that the MBTA is providing their equipment. Is there a scope available on what exactly is being purchased and installed by the MBTA and what the general contractor will need to provide as part of the install on the busway platforms?

Response 9) Please see the attached CCFVM Repair and Maintenance Manual inserted as pages A00803-135.1 to 135.60 issued via this addendum.

Question from SPS New England, Inc. Dated 09/03/2014 @ 11:17 AM:

Question 10) Please confirm if \$5,000,000/\$10,000,000 Combined bodily injury and property damage is acceptable for Railroad Protective Liability Insurance or if a total \$10,000,000/\$20,000,000 limit is required?

Response 10) Railroad Protective Liability Insurance and Protective Property Damage Liability Insurance shall be obtained by the Contractor in the amount of \$5,000,000/\$10,000,000 on behalf of the MBTA, the Operating Railroad, CSXT and PanAM. Please see revised page A00801-23 issued via this addendum.

Questions from Barletta Companies Dated 09/03/2014 @ 1:25 PM:

Question 11) Please clarify which material is to be used where fill is required between existing grade and bottom of proposed subgrade (i.e. behind Retaining Walls No. 1 & 2 and along Busway)? Under which item is this material to be paid?

Response 11) If existing excavated soils are unsuitable for reuse as fill under pavements and structures, as determined by the Engineer, Special Borrow shall be used as backfill material and paid for under Item 150.1.

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Question 12) Sheet 38 notes possible railroad tracks and/or reinforced concrete slab or ties to be paid under item 120.1 "Unclassified Excavation". Please clarify as item 120.1 "Unclassified Excavation" is not currently included in the bid form. If the removal of track, slab, and ties is to be the responsibility of the contractor, are there as-built drawings that can be made available?

Response 12) Note 1 on Sheet 38 is revised and should read: **"POSSIBLE BURIED RAILROAD TRACKS AND/OR REINFORCED CONCRETE SLAB OR TIES MAY EXIST ALONG WASHINGTON AVENUE. PAYMENT FOR THE REMOVAL OF THESE ITEMS SHALL BE INCLUDED UNDER 120. - EARTH EXCAVATION (FOR RAILROAD TRACKS); ITEM 127.1 - REINFORCED CONCRETE EXCAVATION (FOR SLABS); AND ITEM 184.1 - REMOVAL OF TREATED WOOD PRODUCTS (FOR TIES)".**

Question 13) Drawing sheet 18 "Typical Water Main Trench" shows the 5 ft of cover over pipe as "Gravel for Backfilling Structures and Pipes". Please clarify if payment for backfill is under item 151.2 or if backfill is to be included in the pipe item as stated in the specification for the pipe.

Response 13) Gravel for backfilling the water pipe is included in the cost of the pipe.

Question 14) Please provide a trench detail for the drainage pipe.

Response 14) A Drainage Trench Detail has been added to Sheet 14 and included with this Addendum No. 3.

Question 15) What work is paid under 151.2 Gravel borrow for backfilling structures and pipes?

Response 15) Item 151.2 is for backfilling around structures including bridge piers and low retaining walls (not including bridge abutments or the soldier pile & lagging walls), under drainage pipes to replace unsuitable soils, and backfill over drainage pipes in excess of 5' in depth.

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Question 16) Drawing Sheet 26 Note at Spruce St. Crossing states” Reconstruct Existing Railroad Crossing(By Others) for Gate Relocations and Other work under this contract see sheets 153 to 169. On sheets 153,156 and 157 and Specification 490.01 it appears all of the rail, ties, rail seals and paving of the grade crossing are part of this contract and not”by others”. Is the trackwork limited to the 39’rail section, 11’6”Bonded rail plugs and 22 ft transition rail on either side of the crossing? Please clarify.

Response 16) As indicated on the Plans, Trackwork construction includes reconstruction of the railroad crossing at Spruce Street. No trackwork is proposed at Everett Avenue or Arlington Street. Railroad signal work is proposed at all three locations.

Question 17) Please confirm there is no Grade Crossing Trackwork-Rail, Rail welds, Rail seals, Ties, Pavement, etc. at the following locations:

- Everett Avenue
- Arlington/Sixth Street Intersection

Response 17) As indicated in Response 6 above, no track work is proposed at the Everett Avenue and Arlington/Sixth Street Intersections. The work at these locations does include railroad signal work.

Question 18) Drawing Sheet 29 shows Proposed Access Ramps (By Others) Please confirm that this work is not part of the contract and is scheduled to be done after this contract is complete.

Response 18) The Proposed Access Ramps (By Others) is not part of this contact.

Questions from The Middlesex Corporation Dated 09/04/2014 @ 10:58 AM:

Question 19) We respectfully request that the Department consider removing Class 6A-Transit/Railroad Signaling as a required MBTA prequalification class for the Prime General Contractor. This is a specialty category, with work most frequently performed by specialty subcontractors. On this project, this trade does not comprise a major portion of the work. These requirements will incorrectly preclude several capable firms from submitting a bid for this project.

Response 19) The pre-qualification requirements have been revised for this project. Please see revised Document 00102 – 1 issued via this addendum.

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Question 20) Can you provide a list of General Contractors prequalified in MBTA Classes 1, 2, 3 & 6A & MassDOT Highway – Construction?

Response 20) The pre-qualification requirements have been revised for this project. Please see revised Document 00102 – 1 issued via this addendum.

Question 21) A00801-251 Item 996.01-996.04 Cast-In-Place Concrete calls for using 4000 psi, ¾”, 610 cement concrete for the base leveling pad. There is a detail on sheet 193 that shows a leveling 5x5x1/2 angle w/ ½”, 50 durometer neoprene pads. Please explain which detail is correct.

Response 21) Both details are correct. It will be the contractor’s option to support the precast concrete panels by utilizing either a concrete base leveling pad, or the 5x5x½ support angle with neoprene pad.

Question from SPS New England, Inc. Dated 09/04/2014 @ 2:20 PM:

Question 22) Are the stay in place forms shown on the Washington Ave bridge drawings under the sidewalk in accordance with the current engineering directive?

Response 22) The stay-in-place forms as shown on the Plans are in accordance with the current engineering directive (E-12-002) since only the deck bays that are directly under the curb or barrier need to have removable forms

Questions from A. A. Will Corporation Dated 09/04/2014 @ 4:22 PM:

Question 23) In the bid documents one of the MBTA prequalification requirements indicated is CLASS 6A – TRANSIT/RAILROAD SIGNALING, which Heavy-Highway General Contractors typically do not have since the work is performed by specialty subcontractors and not by the General Contractor. Therefore, the prequalification requirement should be applicable to the subcontractor performing the signal work and not the General Contractor (unless the GC is self-performing). Please advise.

Response 23) The pre-qualification requirements have been revised for this project. Please see revised Document 00102 – 1 issued via this addendum.

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Question 24) Addendum No. 2 indicates for Items 996.01 thru 996.04 that 4000 psi, 3/4 in., 610 Cement Concrete is for the base leveling pad. A leveling pad is not shown on the wall plans or details, and it appears the precast wall panels sit on the 5x5 support angle and neoprene shown on Sheet No. 194. Please clarify

Response 24) See answer to question #21 above.

Question 25) For Items 996.01 thru 996.04 there is a section titled Bituminous Damproofing, however underneath the specification describes waterstops, filter fabric, expansion joints and expansion anchors. Damproofing is not shown on the wall plans or details. Please clarify where damproofing is required for these walls.

Response 25) The title “Bituminous Damproofing” in the Special Provisions is a misnomer. Bituminous damproofing is not required. However, the treatment behind the proposed walls should be as indicated on the Plans and as described in the Special Provisions.

Questions from P. Gioioso & Sons, Inc. Dated 09/05/2014 @ 9:34 AM:

Question 26) Regarding revised Notice To Contractors (page 00102-1) provided in Addendum #1, what MBTA Prequalification levels are required for the various classes of MBTA work? The Trackage and Track Signals work on the project both appear to be substantially less than \$500,000. Alternatively, we request that this specification be revised to require that the contractor or subcontractor performing the work be prequalified in the appropriate MBTA Class of Work, by subcontractor approval or other means, at the time of construction.

Response 26) The pre-qualification requirements have been revised for this project. Please see revised Document 00102 – 1 issued via this addendum.

For the Signals work, please clarify:

Question 27) Under what pay item will the signals work shown on Sheet 156 be paid?

Response 27) All railroad signal work under this contract, as indicated on the Plans and Special Provisions, are included in the Contract Lump Sum Item No. 490.01 – Railroad Grade Crossing Reconstruction.

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Question 28) Please confirm that the only Grade Crossing Reconstruction work required on the project is at Spruce St., as shown on Plan Sheet 153, 157, and 158, to be paid under Bid Item 490.01.

Response 28) Trackwork construction includes reconstruction of the railroad crossing at Spruce Street. No trackwork is proposed at Everett Avenue or Arlington Street. Railroad signal work is proposed at all three locations.

Question 29) Special Provisions for Items 815.1 to 815.4, page 156, states that the “Work also includes construction of new infrastructure for future traffic signals at the Everett Ave and Spruce St intersections.” Also on that page, “A list of major traffic signal items required is included on the plans.” Please clarify what aspects of these signals are the responsibility of this contract. Please indicate where the “list of major traffic signal items” can be found, or please provide that list. Is it the intent of this contract to activate these signals prior to completion of this contract?

Response 29) Installation of infrastructure elements for future traffic signals at Everett and Spruce, to be included under this contract, include conduits, handholes, mast arms & foundations. Tables listing the “Major Items Required” for traffic signal locations 2, 3, and 4 have been added to the plans and included in Addendum No. 3.

Question 30) Please indicate on what Plan Sheet can the work for Item 815.4 Traffic Control Signal Location #4 be found ? On page 156 of the Special Provisions, this work is indicated as the signal upgrades at the intersection of Eastern Ave and Central Ave.

Response 30) A table identifying “Major Items Required” for the Traffic Control Signals at Location No. 4 has been added to the Plans included with this Addendum No. 3.

Question 31) On Sheet 160, typical Electrical Manhole. Are these the details for the Handholes (designated as HH#) found on the Signal System Plans, sheets 153, 155, and 156? Will these be paid under Items 811.22 and/or 811.31?

Response 31) No, the Electrical Manhole on Sheet 160 is for the Transition Manhole for the Railroad Cable Relocation work indicated on Sheet 159, and is included in Contract Lump Sum cost for item 490.01 – Railroad Grade Crossing Reconstruction. The Handholes on Sheets 153, 155 & 156 are for the railroad signal system work and are also included in Contract Lump Sum cost for item 490.01 – Railroad Grade Crossing Reconstruction. Item 811.22 is for handholes for the Lighting System; Item 811.31 is for handholes/pull boxes for the traffic signal system.

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Question 32) On Sheets 153-156, will the 4" Galvanized Rigid Steel (GRS) conduit found on these sheets be paid under Item 806.4 ?

Response 32) The 4" GRS Conduit and other elements related to the railroad track and signal work shall be included in the Contract Lump Sum Price for Item 490.01 – Railroad Grade Crossing Reconstruction.

Regarding the Lighting drawings, sheets 86 to 114, please clarify the following:

Question 33) On Sheet 86 the legend indicates 24"x36"x18"DP handholes, which appear for the lighting work and 36"x48"x48"DP handholes which appear for the communications work. However the details on Sheet 114 shows Handholes as 1'x2' and 3'x4'. Please clarify the handhole sizes.

Response 33) The handholes should be 1'x 2' for the lighting work and 3' x 4' for the communications work. This has been clarified in the revised Plans under this Addendum No. 3.

Question 34) The Special Provisions for Pay Item 804.3 3" Electrical Conduit Type NM, under the heading Conduit Crossing Roadways indicates that "After conduit installation, the trench shall be backfilled with Controlled Density Fill (CDF)". The majority of the 3" NM Conduit for the Busway lighting (under the Busway pavement) is shown as concrete encased per the legend on Sheet 86. Please clarify whether concrete encasement is required, and/or whether CDF backfill or encasement is required for the 3" conduits under the busway pavement.

Response 34) Controlled Density Fill is only needed at the existing roadway crossings (across Everett Avenue, Spruce Street, Arlington Street and Cottage Street), and only at the direction of the Engineer. It is not needed under full depth construction areas of the busway.

Question 35) If concrete encasement is required for the 3" Lighting conduit, can this conduit be encased together with the communications conduit, as appears to be shown on the Detail on Sheet 113 (Underground Conduit Trench for Multiple Conduits) ?

Response 35) The detail for "Underground Conduit Trench for Multiple Conduits" shown on Sheet 113 is for direct buried conduit.

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Question 36) Bid items 811.22 and 811.31 are for DOT standard handholes, size 12x24 (tapered) and 12x12 (square) respectively. These bid items do not correspond with the Legend shown on sheet 86, or the details shown on sheet 114. Please clarify the sizes for Lighting and Communications handholes, and please confirm under what pay items will the handholes on sheets 86-114 be paid?

Response 36) As indicated in Response to Question 7 above, Bid Item 811.22 will be for the 1' x 2' handholes for the lighting work (Sheet 86 has been revised to clarify the size). Item 811.31 – Pull Box 12 x 12 inches – SD2.031 are pull boxes for the traffic signal systems. Payment for all other handholes and pull boxes will be included in the items of work to which they pertain.

Question 37) Please clarify if the contractor is responsible for providing the Communications Enclosures shown on sheets 87, 91, 95, and 100. If yes, please provide details of the enclosures, including foundations if any. Under what pay item will these be paid?

Response 37) The Communications Enclosures are included as part of the work under this contract. Details are indicated on Sheet 214 – Security Equipment Cabinet Details and Line Diagram. Refer also to Appendix A – MBTA Construction Specifications for Bus Rapid Transit Station Construction. The Enclosures are included under the Contract Line Item No. 745.01 – Bus Rapid Transit Stations.

Question from SPS New England, Inc. Dated 09/05/2014 @ 3:22 PM:

Question 38) Under Section 16700 – Power Wire and Cable the description reads that this section specifies furnishing and installing power wire and cable for the AC power distribution system of the Talbot Avenue Commuter Rail Station and the Talbot Avenue and Woodrow Avenue Bridge Replacements. The Talbot Avenue Commuter Rail station is a separate project. Is this work still to be included under lump sum pay item – 745.01 – Bus Rapid Transit Stations?

Response 38) That reference was in error. Please disregard. See revised Document A00803-245 issued via this addendum.

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Questions from Barletta Companies Dated 09/05/2014 @ 4:40 PM:
and Dagle Electrical Construction Corp. Dated 09/08/2014 @ 7:02 AM

Question 39) Please identify the manufacturer of the Sonet multiplexer shown on drawing sheet #217 (communication rack detail 4) for each station. This is also mentioned in PAS Variable Message Sign spec 16770; paragraph 1.2 D as an existing High Street connection to the DCAM building at 200 Arlington Street in Chelsea. Manufacturer and model required for pricing.

Response 39) **This question will be answered in a later addendum.**

Question 40) Drawing Sheet 217- General notes 1 & 4 Indicate both a primary and secondary video storage bank. Specification section 16840 page 22 paragraph 2.20, B says the Video storage is existing. Please clarify if both Primary and Secondary storage is to be furnished for this project.

Response 40) **This question will be answered in a later addendum.**

Question 41) Please identify the Raid configuration for the storage devices ie. Raid 5, 6e, 6x.

Response 41) **This question will be answered in a later addendum.**

Question 42) Please identify the number of days of storage required for both the primary and secondary video storage banks.

Response 42) **This question will be answered in a later addendum.**

Question 43) Drawing Sheet 264 shows the top 2 courses of Granite block darkened. Is this new New Block? Existing Block? Or Cast in place Concrete with Formliner? The moment slab Details on Sheet 265 don't appear to match the Elevation on Sheet 263

Response 43) **This question will be answered in a later addendum.**

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Question from Mass Bay Electrical Corp. Dated 09/08/2014 @ 8:32 AM:

Question 44) The bid items indicate four locations for new traffic signals, but the plans only identify one location. Could you please include the remaining traffic signals locations in the plan set.

Response 44) The one location indicated on the Plans is a full traffic signal system. The other three locations are only for infrastructure elements for future traffic signal systems. These infrastructure elements include conduit, handholes, mast arms & foundations.

Questions from Atlantic Bridge & Engineering. Dated 09/08/2014 @ 10:07 AM:

Question 45) The Specifications for the steel piles for Wall No.'s 1 thru 4 indicate that the material is to conform to the relevant provisions of Section 960 of the Standard Specifications (Ref. Page A00801-250). Please clarify what provisions of this specification section are applicable to the fabrication of the steel piles for this project. (e.g. Preblast of raw steel materials prior to fabrication? Does work need to be performed by MassDOT approved fabricator?)

Response 45) This question will be answered in a later addendum.

Question 46) Reference is made to Contract Sheet No. 194 of 346. Please provide the size of the headed shear connectors that are to be installed to the steel piles for Wall No.'s 1 to 4.

Response 46) This question will be answered in a later addendum.

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Questions from Intelligent Systems & Controls Contractors, Inc. Dated 09/08/2014 @ 2:36 PM:

Question 47) The PA/ESS Section includes the following paragraph “Designated Passenger Station Systems shall provide telephone access into the OCC Announcement Control System, which shall allow remote announcements to various Passenger Station PA Systems or groups of Passenger Station Systems via a secure access pass-code.” The existing PA/ESS system does NOT support this functionality.

Is the intent to add this feature to the existing functionality of the existing Arinc PA/VMS? This can be added but at a significant additional cost.

Response 47) This question will be answered in a later addendum.

Question 48) The CCTV Section specifies “Three(3) Two-Post Equipment Racks shall be installed in each of the four Communications Equipment Enclosures as depicted in the Contract Drawings”, and the drawings support that. The PA/ESS Section specifies “Furnish and install Public Address equipment case with a thermostatically controlled and vent fan. Power to the heater and vent fan to be provided on separate circuits from the power distribution panel.

Is a 2-Post open frame rack the correct item to be furnished for the Public Address equipment?

Response 48) This question will be answered in a later addendum.

③ **ADDENDUM NO. 3, SEPTEMBER 9, 2014**① **ADDENDUM NO. 1, AUGUST 29, 2014**

DOCUMENT 00102

**NOTICE TO CONTRACTORS**

Electronic proposals for the following project will be received through the internet using Bid Express until the date and time stated below and. will be posted on www.bidx.com forthwith after the bid submission deadline. No paper copies of bids will be accepted. Bidders must have a valid digital ID issued by MassDOT in order to bid on projects. Bidders need to apply for a Digital ID at least 14 days prior to a scheduled bid opening date with Bid Express.

TUESDAY, SEPTEMBER 16, 2014 at 2:00 P.M.**CHELSEA**

**Construction of the Silverline Gateway Busway,
BRT Stations and Bridge Replacement (Steel) Br. No. C-09-001
Washington Avenue over the MBTA Railroad
(604428)**

PROJECT VALUE = \$38,260,000.00

- ③① For the track and signal systems work on the project, bidders must be pre-qualified by the MBTA in the following classes of work:**

MBTA CLASS I – GENERAL TRANSIT CONSTRUCTION

MassDOT Highway Division's requirement for bidders to be prequalified in the category of HIGHWAY – CONSTRUCTION remains in effect.

- ③ MBTA signal, power and track work must be completed by a contractor or subcontractor prequalified in the appropriate MBTA Class. At the time of the bid, assurance must be provided by the bidder that the work under the appropriate Class will be performed by the pre-qualified bidder or pre-qualified subcontractor.**

An award will not be made to a Contractor who is not pre-qualified by the Department prior to the opening of Proposals.

Contractors intending to bid on this project must first complete a "Request for Proposal Form"(R-109 Form) and e-mail an electronic copy of this document to the MassDOT Director of Prequalification for approval. Please e-mail these documents to prequal.r109@state.ma.us .

Blank "Request for Proposal Forms"(R-109 Forms) can be obtained at <http://www.massdot.state.ma.us/highway/Departments/PrequalificationofHorizontalConstructionForms.aspx>

Select the link "Request for Official Proposal Form (R-109 Form)"

ADDENDUM NO. 1, AUGUST 29, 2014**NOTICE TO CONTRACTORS** (Continued)

Upon approval, the official bidder shall be entitled to receive an officially numbered Compact Disc (CD) containing the plans and specifications, free of charge. Other interested parties may also receive an informational copy of the CD containing the plans and specifications, free of charge. It should be noted that informational copies can not be used for bidding purposes. The bidding for and award of the contract for this project is to be in accordance with the requirements of Massachusetts General Laws Chapter 30 § 39M.

All parties who wish to have the CDs shipped to them must provide a completed mailing label with an approved carrier account number for overnight mail service (i.e. – Federal Express) to the MassDOT Bid Document Distribution Center, Room 6261, 10 Park Plaza, Boston, MA 02116.

A Proposal Guaranty in the amount of 5% of the value of the bid is required either using BidX's online form or by separately submitting an electronic copy of the Proposal Guaranty via e-mail to MassDOTBidBonds@dot.state.ma.us.

Bidders are on notice that this project is subject to the schedule of prevailing wage rates as determined by the Commissioner of the Massachusetts Department of Labor and Workforce Development, Division of Occupational Safety.

Plans will be on display and information will be available at the MassDOT Boston Office and at the District Office in BOSTON.

This Contract contains price adjustments for hot mix asphalt and Portland cement mixtures, diesel fuel, and gasoline. For this project the base prices are as follows: liquid asphalt \$640.00 per ton, Portland cement \$118.00 per ton, diesel fuel \$3.329 per gallon, and gasoline \$3.207 per gallon. MassDOT posts the **Price Adjustments** on their Highway Division's website at <http://www.massdot.state.ma.us/Highway/> under the following link sequences:

Doing Business With Us
Construction
Price Adjustments

STEEL PRICE ADJUSTMENT

This Contract contains Price Adjustments for steel. See Document 00813 - PRICE ADJUSTMENT FOR STRUCTURAL STEEL AND REINFORCING STEEL of the Special Provisions for their application.

The Base Prices for these items on this project are as follows:

Rebar

ASTM A615/A615M Grade 60 (AASHTO M31 Grade 420) Reinforcing Steel = \$0.37 per pound

ADDENDUM NO. 3, SEPTEMBER 9, 2014

DOCUMENT 00715



INTERIM SUPPLEMENTAL SPECIFICATIONS

(English / Metric Units)

DATE: September 5, 2014

The 1988 *Standard Specifications for Highways and Bridges*, the 1995 *Standard Specifications for Highways and Bridges (Metric)* and the *Supplemental Specifications dated June 15, 2012 (combined English and Metric)* are amended by the following modifications, additions and deletions. These Interim Supplemental Specifications prevail over those published in the Standard Specifications and the Supplemental Specifications.

The MassDOT-Highway Specifications Committee has issued these Interim Supplemental Specifications for inclusion into each proposal until such time as they are approved as Standard Specifications.

Contractors are cautioned that these Interim Supplemental Specifications are periodically updated and may vary from project to project.

ALL SECTIONS

(SUPPLEMENT C2012-1) Replace this section with the following:

Global Changes

Replace the words *Qualified Product Listing maintained by the Research and Materials Division, 400 D Street, South Boston Ma. 02110-1953, telephone number 617-526-8686* and all variations thereof with *Qualified Construction Materials List* at each occurrence.

Change the words *Bituminous Concrete* and *Class I Bituminous Concrete Type I-1* to *Hot Mix Asphalt* at each occurrence.

Change the words *Cement Concrete Masonry* to *Cement Concrete* at each occurrence.

Change the words *Linear Foot* and *Vertical Foot* to *Foot* at each occurrence.

Change the words *ground granular blast-furnace slag* to *slag cement* at each occurrence.

ADDENDUM NO. 3, SEPTEMBER 9, 2014
DIVISION I
GENERAL REQUIREMENTS AND COVENANTS

SECTION 3.00
AWARD AND EXECUTION OF CONTRACT

SUBSECTION 3.04 Contract Bonds Required.

(page 11 English, page I.14 Metric, page SUPPLEMENT C2012-7) Replace the last paragraph of the subsection with the following:

All alterations, extensions of time, extra work and any other changes authorized under these specifications, or under any part of the Contract may be made by the Department. The Contractor shall notify the surety or sureties regarding changes to the Contract. The Contractor shall provide evidence of revised bond.

Where the Contract utilizes additional artisans, equipment rental, materials, engineering services and specialty services to complete work assignments approved by the Engineer, the Contractor shall notify the surety of the additional work and provide the Department with documentation that the bond has been revised to cover such work.

SECTION 4.00
SCOPE OF WORK

SUBSECTION 4.03 Extra Work (Also see Subsection 4.05).

(page 12 English, page I.15 Metric) Change the words Subsection 8.10, Part F. to Subsection 8.10. in the second paragraph.

SUBSECTION 4.04 Changed Conditions.

(page I.16 Metric) In the third sentence of the second paragraph delete the words "... or a change in the cost of performance of the work...".

(page 13 English, page I.16 Metric) Replace the second sentence in paragraph (a) with the following:

The Engineer shall promptly investigate the conditions, and shall promptly prepare a written report of the findings, with a copy to the Contractor. If the Engineer finds that such conditions as have been described in detail by the Contractor do exist and in fact do so differ materially or substantially, an equitable adjustment shall be made and the Contract modified in writing accordingly.

SUBSECTION 4.05 Validity of Extra Work.

(page 14 English, page I.17 Metric) Delete the words "... Chapter 29, Section 20A and...".

SECTION 5.00
CONTROL OF WORK

SUBSECTION 5.02 Plans and Detail Drawings.

(page SUPPLEMENT C2012-9) Replace the second paragraph of this subsection with the following:

Contract drawings, supplemental plans and detail drawings designed by the Department are part of the complete plans. Shop drawings, detail drawings, erection drawings, catalog cuts, temporary structures and other plans designed and or submitted by the Contractor as required in the Specifications shall, upon approval by the Engineer, become part of the complete set of plans.

ADDENDUM NO. 3, SEPTEMBER 9, 2014**SUBSECTION 5.02** (Continued)

(SUPPLEMENT C2012-10) Replace the 8th paragraph of the Subsection (first paragraph of the page) with the following:

The Contractor shall submit two sets of full-scale shop drawing prints to the Engineer for approval. If corrections are required, one set of the marked-up drawings will be returned to the Contractor for revision and subsequent re-submittal. The Engineer shall make all copies of the approved shop drawings as indicated in Table 1 of Subsection 5.02 and will distribute the drawings. No changes shall be made to the approved drawings without the written consent of the Engineer.

SECTION 6.00 CONTROL OF MATERIALS

SUBSECTION 6.01 Source of Supply and Quality.

(page 20 English, page I.26 Metric, SUPPLEMENT C2012-12) Replace the 11th and 12th paragraphs in the Supplement, both beginning with Materials for..., with the following:

Materials for permanent construction shall be new, shall conform to the requirements of these specifications, and shall be approved by the Engineer.

Materials for temporary structures or supports adjacent to traveled ways, the failure of which would compromise the safety of the public or the traveled ways, need not be new but shall conform to the requirements of these specifications, and shall be approved by the Engineer. For any material that is not new, the Contractor shall be required to submit certification by a Structural Professional Engineer that the material meets the requirements for the intended use.

These requirements shall not apply to gantry systems and supports as well as other mechanized systems.

SECTION 7.00 LEGAL RELATIONS AND RESPONSIBILITY TO THE PUBLIC

SUBSECTION 7.02 Pollution Prevention.

(SUPPLEMENT C2012-16) Under B. Construction Dust Control, delete the words wet mopping in the second paragraph.

SUBSECTION 7.04 Motor Vehicles.

(page 24 English, page I.32 Metric) Replace the first paragraph with the following:

All motor vehicles (except vehicles used solely for transporting employees to and from the project) and trailers used wholly or in part within the Commonwealth by the Contractor or any Subcontractor, or by any person directly or indirectly employed by them in the execution of the Contract, shall be registered in the Commonwealth of Massachusetts and bear Massachusetts registration plates except as stipulated in Subsection 7.03.

SUBSECTION 7.09 Public Safety and Convenience.

(page 27 English) Change the word include to included in the last sentence of the third paragraph.

ADDENDUM NO. 3, SEPTEMBER 9, 2014**SUBSECTION 7.23 Archeological and Paleontological Discoveries.**

(page 37 and 38 English, page I.47 Metric) Replace this Subsection with the following;

7.23 Discovery of Unanticipated Archaeological and Skeletal Remains.

Should any archaeological remains be encountered during any phase of construction, the Contractor shall immediately cease all construction activities in the discovery area, secure the area and notify the Engineer. The Engineer shall immediately notify the MassDOT Environmental Services Section in Boston Headquarters Office. The MassDOT Archeologist shall inspect the remains and their context in order to evaluate the discovery. In the event a potentially significant archaeological find is encountered, as determined by the MassDOT Archeologist, the Contractor shall carefully protect the discovery area by placing snow fencing and/or flagging (with an approximately 30-foot buffer zone) around the find(s). The MassDOT Archeologist shall notify the Federal Highway Administration (if the project is federally funded), the Massachusetts State Archeologist, the Massachusetts State Historic Preservation Officer/Executive Director of the Massachusetts Historical Commission and other relevant parties (the Massachusetts Commission on Indian Affairs, Tribal Historic Preservation Officers) of the discovery and serve as the liaison on all subsequent actions. Outside the protected discovery area, construction work may continue.

Construction may not resume in the discovery area until the MassDOT Archeologist has secured all necessary regulatory approvals and given the approval to continue to the Engineer.

If skeletal remains are discovered during construction, the Contractor shall immediately cease all work in the discovery area, secure and protect the area and notify the Engineer as stipulated above. The Engineer shall immediately contact the State Medical Examiner, the police and the MassDOT Archeologist. If the skeletal remains prove to be human and more than 100 years old, as determined by the State Medical Examiner, the MassDOT Archeologist shall consult with the Massachusetts State Archeologist and other relevant parties pursuant to all procedures and protocols under the Massachusetts Unmarked Burial Law (M.G.L. Chapter 38, Section 6; M.G.L. Chapter 9, Section 26A and 27C; and M.G.L. Chapter 7, Section 38A) and Section 106 of the National Historic Preservation Act as amended, and its implementing regulations for emergency situations and post-review discoveries [36 CFR 800.12(b)(2) or 36 CFR 800.13(b)].

SECTION 9.00 MEASUREMENT AND PAYMENT

SUBSECTION 9.03 Payment for Extra Work.

(page 45 English, page I.57 Metric and SUPPLEMENT page C2012-25) Replace this Subsection with the following:

A. Payment for work for which there is a unit price provided for in the Contract.

Where the Contract contains a unit price for work and the Engineer orders Extra Work for work of the same kind as other work contained in the Contract and is performed under similar physical conditions, the Contractor shall accept full and final payment at the Contract unit prices for the accepted quantities of Extra Work done.

No allowance will be made for any increased expenses or any damages whatsoever.

B. Payment for work or materials for which no price is contained in the Contract.

If the Engineer directs, the Contractor shall submit promptly in writing to the Engineer an offer to do the required work on a lump sum or unit price basis, as specified by the Engineer. The stated price, either lump sum or unit price, shall be divided so as to show that it is the sum of: (1) the estimated cost of direct labor, materials, and the use of equipment, plus 10 percent of this total for overhead; (2) plus the actual cost of Workmen's Compensation and Liability Insurance, Health, Welfare and Pension benefits, Social Security deductions, Employment Security Benefits, and such additional fringe benefits which the Contractor is required to pay as a result of Union Labor Agreements and/or is required by authorized governmental agencies; (3) plus subcontractor or a Public or Private Utility costs; (4) plus 10 percent of the total of (1), (2) and (3); (5) plus the estimated proportionate cost of surety bonds.

Unless an agreed lump sum and/or unit price is obtained from above and is so stated in the Extra Work Order the Contractor shall accept as full payment for work or materials for which no price agreement is contained in the Contract an amount equal to the following: (1) the actual cost for direct labor, material (less value of salvage, if any) and use of equipment, plus 10 percent of this total for overhead; (2) plus actual cost of Workmen's Compensation and Liability Insurance, Health, Welfare and Pension benefits, Social Security deductions, and Employment Security Benefits; (3) plus subcontractor or a Public or Private Utility costs; (4) plus 10 percent of the total of (1), (2) and (3); (5) plus the estimated proportionate cost of surety bonds.

ADDENDUM NO. 3, SEPTEMBER 9, 2014**SUBSECTION 9.03** (Continued)

Costs incurred for traffic police, railroad flagging and permits will be reimbursed without mark-up for overhead or profit.

No allowance shall be made for general superintendence and the use of small tools and manual equipment.

The Contractor shall, when requested by the Engineer, furnish itemized statements of the cost of the work ordered and give the Engineer access to all accounts, bills and vouchers relating thereto, and unless the Contractor shall furnish such itemized statements, access to all accounts, bills and vouchers, the Contractor shall not be entitled to payment for any items of extra work for which such information is sought by the Engineer.

C. Equipment Rates.

In the event there arises the need for determination of costs of use of equipment as part of “actual costs” or “cost of performance” or “damages” under Subsections 4.04, 7.16, 8.05, 9.02 and/or 9.03, or under Chapter 30 of the Massachusetts General Laws, such costs for use of equipment shall be established in accordance with the following:

(1) “Construction equipment” as used herein means equipment in sound workable condition, either owned or controlled by the Contractor or the Subcontractor at any tier, or obtained from a commercial rental source, and furnished for use under the contract.

(2) Allowable hourly ownership and operating costs for contractor-owned or subcontractor-owned equipment shall be determined as follows:

a) Actual cost data from the Contractor’s accounting and operating records shall be used whenever such data can be determined for hourly ownership and operating costs for each piece of equipment, or groups of similar serial or series equipment. Actual costs shall be limited to booked costs of the annual accounting period or periods during which the equipment was utilized on the Contract, and will not include estimated costs not recorded and identifiable in the Contractor’s formal accounting records. The Contractor shall afford Department auditors full access to all accounting, equipment usage, and other records necessary for development or confirmation of actual hourly cost rates for each piece of equipment, or groups of similar serial or series equipment. The Contractor’s refusal to give such full access shall invalidate any request or claim for payment of the equipment costs. When costs cannot be determined from the Contractor’s records, hourly equipment cost rates may be determined under (b) and (c) below.

b) When the Department ascertains that it is not practicable to determine actual equipment cost rates from the Contractor’s records, hourly equipment cost rates for equipment owned by the Contractor may be determined by the use of rate schedules (with adjustments) contained in the EquipmentWatch Rental Rate Blue Book(s); said publication is incorporated herein by reference.

The Contractor shall provide to the Department, in a format prescribed by the Department, sufficient descriptive ownership and operating records and documentation for each piece of equipment subject to the extra work so that the equipment rates may be determined and adjusted as follows:

- (1) Hourly equipment rates shall be the FHWA rate contained in the Rental Rate Blue Book adjusted by application of the Rate Adjustment Tables (for machine age adjustment) plus adjustments to eliminate equipment overhead (indirect ownership) plus regional adjustments (the weekly, hourly and daily rates listed in the Rental Rate Blue Book will not be used). This rate shall be defined as ‘Adjusted FHWA Rate’.
- (2) Equipment standby rates shall be the ‘Adjusted FHWA Rate’ as described in (1) above, minus the operating rate and reduced by 50%. Standby rates shall not include operating rates:
$$\text{Equipment standby rate} = (\text{Adjusted FHWA Rate} - \text{Estimated Operating Rate})/2$$

The number of equipment hours to be paid for under the extra work or force account work shall be the number of hours that the equipment is actually used on a specific extra work or force account activity.

The current version of the Rental Rate Blue Book will be used in establishing equipment rates. The version applicable to specific extra work or force account work will be the version in effect as of the first day of work is performed on that force account work and that rate shall apply throughout the period the force account work is being performed.

The Department may allow calculation of equipment rates based upon other equipment rate books and guides (i.e. Construction Equipment Ownership and Operating Expense Schedule, Region One published by the Army Corps of Engineer’s) or hybrid rates determined to be reasonable by the Department.

ADDENDUM NO. 3, SEPTEMBER 9, 2014**SUBSECTION 9.03** (Continued)

c) In those cases where a 10 percent additive for overhead and profit is to be superimposed on the equipment costs as provided in Subsections 4.04, and 9.03B, equipment cost rates determined under (a) and (b) above shall exclude any overhead costs such as equipment insurance, licenses, or taxes. The 10 percent additive shall compensate the Contractor for all overhead costs, including equipment overhead, general superintendence, small tools, manual equipment, field overhead, and central office overhead. Where the 10 percent overhead additive is not applicable, overhead items clearly related to equipment, (equipment insurance, licenses, taxes), shall be included in the equipment rates; provided, however, that such costs shall be identified and eliminated from any other direct or indirect costs or damages payable by the Department under the Contract. No element of profit shall be allowable in equipment cost rates for Contractor-owned equipment; it being understood that a 10 percent profit additive will be superimposed upon equipment costs when called for by the Contract.

(3) Reasonable hourly costs of renting equipment are allowable subject to the Contractor producing adequate records supporting actual costs incurred, provided further that:

a) Costs such as fuel, lubricants, and minor or running repairs incident to operating such rented equipment that are not included in the rental rate are allowable.

b) Costs incidental to major repair and overhaul of rental equipment are not allowed.

c) Charges for equipment leased or rented from any division, subsidiary organization under common control, or business under common ownership, ordinarily will be reimbursable to the extent that they do not exceed the actual costs of ownership and operating costs determined as in (2), above. Rental cost of equipment leased or rented from any division, subsidiary, affiliate of the Contractor under common control, or business under common ownership, that has an established practice of renting out the same or similar equipment to unaffiliated parties, shall be allowed at rates higher than actual ownership and operating costs, provided that the Contractor furnishes the Department adequate documentation, including the rental and usage records for the same or similar equipment items, demonstrating a reasonable likelihood that the equipment would have been rented out if not used on this Contract, and that the rental rates charged are consistent with rates charged to unaffiliated parties and going market rates. Rental costs under a sale and leaseback arrangement will be allowable only up to the amount the Contractor would be allowed if the Contractor retained title.

(4) Equipment cost rates determined in (2) and (3) shall be exclusive of labor cost of equipment operators. Such costs shall be reimbursable subject to the Contractor producing adequate payroll and other records sufficient for determination of hours, pay rates, and reimbursable fringe costs as defined in Subsection 4.04 and above.

(5) Except in cases of unit price or lump sum extra work orders approved by the Department before the work is done, actual reimbursable hours of equipment usage and operator time must be adequately documented by the Department force account records or Contractor field and office records maintained during performance of the work in a manner acceptable to the Department. Failure of the Contractor to so maintain time records which adequately segregate added equipment hours caused by extra work required by the Department, or caused by other Department actions cited in the Contractor's claim for damages, from other equipment time worked on the Contract, when maintenance of such records would have been feasible, shall constitute a cardinal omission of the Contractor, invalidating any claim for equipment cost reimbursement.

The above provisions constitute an advanced agreement made in general conformance with intent of Federal Acquisition Regulation 31.105, paragraph (d)(1), said intent being to maximize clarity of understanding and minimize possible disputes with respect to determination of reimbursable actual equipment costs under this Contract.

ADDENDUM NO. 3, SEPTEMBER 9, 2014**DIVISION II
CONSTRUCTION DETAILS****SECTION 101
CLEARING AND GRUBBING****SUBSECTION 101.63 Disposal of Trees.****SUBSECTION 101.64 Disposal of Stumps and Brush.****SUBSECTION 101.65 Disposal of Dutch Elm Diseased Wood.**

(page 54 English, page II.5 Metric) Delete subsections 101.64 and 101.65 and replace Subsection 101.63 with the following:

101.63 Disposition of Trees, Stumps and Brush.

All trees, tree stumps, including trunk base, root flare and attached root mass and brush to be cleared shall be subject to the regulations and requirements of state and local authorities governing the disposal of such materials. Trees, stumps and brush shall be chipped to 1 inch maximum chip dimension and spread to a depth not to exceed 6 inches, in a location approved by the Engineer, at no additional compensation.

The trees, stumps and brush including cuttings, shall not be stored on site for more than 24 hours unless chipped.

If the existing ground in the area is disturbed by any of the work or equipment, the Contractor shall rough-grade and loam and seed if necessary the disturbed areas without additional compensation.

The Contractor shall be responsible for ensuring that any and all plant pests on site shall not be carried off site and shall be either destroyed or otherwise contained on site. Plant pests shall include invasive plants, noxious weeds, insect pests, and plant diseases (including infected plant tissue). Method of destruction or containment shall be approved by the Engineer. If invasive or contaminated material cannot be either destroyed or contained on site, contractor shall submit plans for disposal for approval by Engineer. For current list of plant pests and applicable management procedures see the following on-line references:

Invasive Plants: http://www.massnrc.org/mipag/docs/MIPAG_FINDINGS_FINAL_042005.pdf

Plant Pests: <http://www.massnrc.org/pests/factsheets.htm#commodity>

SECTION 227. DRAINAGE SYSTEM SEDIMENT

(page 79 English, page II.32 Metric) Add the following Section in numerical order:

**SECTION 227
DRAINAGE SYSTEM SEDIMENT****DESCRIPTION****227.10 General.**

The work shall consist of removal and disposal of accumulated sediment, which may contain refuse and other debris, from designated drainage systems, including: drainage structures, pipes, the gutter mouth of curb inlets, and as directed by the Engineer.

ADDENDUM NO. 3, SEPTEMBER 9, 2014**SECTION 227 (Continued)****CONSTRUCTION METHODS****227.21 Regulatory Requirements.**

Drainage system sediment is classified as a solid waste by the DEP and must be handled and disposed in accordance with Solid Waste Management Regulations 310 CMR 19.000, as well as all other applicable DEP policies and guidance.

Sediment must arrive at the disposal facility sufficiently dry since DEP regulations prohibit landfills from accepting materials that contain free draining liquids. A permitted solid waste disposal facility may require characterization of the material prior to accepting it for disposal at the facility. The Contractor shall provide copies of all material shipping records to the Engineer.

227.23 Prosecution of Work.

No casting shall be removed until immediately preceding the work and shall be replaced immediately after the cleaning of the drainage structure and/or pipes is completed. Open catch basins shall not be left unattended. The Contractor shall properly secure the grate locking device after cleaning.

The Contractor shall protect the cast iron hood of drainage structures so equipped, during the sediment removal process. Equipment used to collect drainage system sediment shall be capable of decanting free flowing liquids back into the drainage system. Conditions such as location, extraordinary shape due to conduits or public utility pipes, or off pavement work, may require hand work. Drainage system sediment shall be transported to a disposal facility in trucks that will not spill the material along the roadway. Any sediment falling on the roadway shall be removed by the Contractor at his own expense.

COMPENSATION**227.30 Method of Measurement.**

Sediment removed from drainage structures will be measured by the cubic yard after decanting.

Sediment removed from drainage pipes will be measured by the foot of drainage pipe, regardless of the diameter of pipe from which material is removed.

227.31 Basis of Payment.

Removal and disposal of drainage structure sediment will be paid for at the contract unit price per cubic yard.

Removal and disposal of drainage pipe sediment will be paid for at the contract unit price per foot, regardless of the volume of sediment removed.

The price of these items shall include all labor, equipment, approvals, permits, testing, transportation, disposal and all other incidentals necessary to complete the work.

227.32 Payment Items.

227.3	Removal of Drainage Structure Sediment	Cubic Yard
227.31	Removal of Drainage Pipe Sediment	Foot

ADDENDUM NO. 3, SEPTEMBER 9, 2014**SECTION 477
MILLED RUMBLE STRIPS****SECTION 477 MILLED RUMBLE STRIPS.**

(page 151 English, page II.111 Metric) Add this new Section in numerical order.

DESCRIPTION**477.20 General.**

The work consists of constructing rumble strips on paved highway shoulders by milling grooves into finished hot mix asphalt surfaces.

CONSTRUCTION METHODS**477.61 Equipment.**

The equipment shall self-align with the slope of the roadway surface and/or any irregularities in the roadway surface.

The Contractor shall demonstrate to the Engineer the ability to achieve the desired groove without tearing or snagging the roadway surface prior to beginning the work.

477.62 Installation of Rumble Strips.

Rumble strips shall be installed in accordance with the locations, dimensions and patterns shown on the plans. Rumble strips shall not be installed on shoulders less than 2 feet wide, on bridge decks, within 50 feet of an intersection or major driveway, or on roadways with posted speeds less than 40 MPH.

In areas where acceleration and/or deceleration lanes have no paved outside shoulders, any rumble strips in the outside shoulders shall be terminated at the beginning of each deceleration lane and initiated at the end of each acceleration lane.

477.63 Control of the Work Area.

At the end of each working day, all equipment shall be moved to a location where it does not present a hazard to traffic. The pavement shall be cleaned by sweeping and the work area shall be reopened to traffic.

Pavement millings shall become the property of the Contractor and shall be removed and disposed off site.

COMPENSATION**477.80 Method of Measurement.**

Milled Rumble Strip will be measured by the total length of installed rumble strip. Milled Rumble Strip for Bicycle Traffic will be measured by the total length of installed rumble strip excluding the designed gaps. Breaks at castings, bridge decks, intersections or other breaks will not be measured for payment.

477.81 Basis of Payment.

Payment for Milled Rumble Strip and Milled Rumble Strip for Bicycle Traffic will be made at the contract unit price per foot of rumble strips, complete in place. Such payment will be full compensation for furnishing all equipment and labor for satisfactorily performing the work including cleanup and disposal of excess materials.

477.82 Payment Items.

477.	Milled Rumble Strip	Foot (m)
477.1	Milled Rumble Strip for Bicycle Traffic	Foot (m)

ADDENDUM NO. 3, SEPTEMBER 9, 2014**SECTION 701****SIDEWALKS, WHEELCHAIR RAMPS AND DRIVEWAYS****SUBSECTION 701.20 General.**

(page SUPPLEMENT C2012-61) Replace this subsection with the following:

This work shall consist of the construction of cement concrete wheelchair ramps, hot mix asphalt or cement concrete sidewalks and driveways in accordance with the specifications and within the tolerances established on the plans.

SUBSECTION 701.61 Cement Concrete Sidewalks, Sidewalks at Driveways, and Wheelchair Ramps.

(page SUPPLEMENT C2012-62) Add the following after second paragraph of B. Placing and Finishing Cement Concrete.:

Detectable warning panels conforming to the plans shall be securely incorporated into the work by means acceptable to the Engineer.

SUBSECTION 701.81 Basis of Payment.

(page SUPPLEMENT C2012-63) Replace the first paragraph with the following:

Cement Concrete Sidewalk, Cement Concrete Sidewalk at Driveway and Cement Concrete Wheelchair Ramp will be paid for at the contract unit price per square yard complete in place and shall include detectable warning panels.

SECTION 740**ENGINEER'S FIELD OFFICE AND MATERIALS LABORATORY
(EACH WITH PERTINENT EQUIPMENT)****SUBSECTION 740.41 Engineers Field Office (Type A).**

(page 186 English, page II.146 Metric) Replace number 8 with the following:

8. An electric sanitary hot and cold water cooler, supplied with cups and drinking water, a 3 cubic foot capacity refrigerator with freezer compartment and a 1 cubic foot capacity microwave oven.

SUBSECTION 740.41 Engineers Field Office (Type A).

(page SUPPLEMENT C2012-64, page 187 English, page II.147 Metric,) Replace number 20 b. with the following:

- b. 4 inch or 6 inch (150 mm) Plastic Cylinder Molds and Covers meeting the requirements of AASHTO M 205 and approved for use by the Research and Materials Division. Supply 5 cylinders molds per 150 cubic yards of concrete placement or fraction thereof with a minimum of 50 molds.

ADDENDUM NO. 3, SEPTEMBER 9, 2014**SECTION 801****CONDUITS, MANHOLES, HANDHOLES, PULLBOXES AND FOUNDATIONS****SUBSECTION 801.81 Basis of Payment.**

(page SUPPLEMENT C2012-80) Replace the first paragraph with the following:

The unit contract price per foot, shall be full compensation for furnishing and installing all conduits, couplings, expansion fittings, elbows, bends, caps, sleeves, clamps, hangers, reducers, tees, jointing compound, sealing compound, cement concrete required in Subsection 801.60-F and 801.60-I, planking required in Subsection 801.60-G and gravel required in subsection 801.60-B; for placing the electrical conduit in accordance with these specifications, including all excavation (except Class B Rock) or jacking required, backfilling of the trenches, chipping or sawing of pavement, bedding or hanging of conduit and all other work incidental to the construction of the conduit system, except that when electrical conduit is included on any project as an integral part of a traffic control signal or Highway Lighting System and the conduit is not shown as a pay item, it shall be considered as incidental to the construction and be included in the lump sum price for such systems.

SECTION 815**TRAFFIC CONTROL SIGNALS****SUBSECTION 815.80 Method of Measurement.**

(page 237/238 English, page II.200 Metric) Add the following paragraph after the third paragraph:

Wire Loop Installed in Roadway will be measured by the foot along the sawcut or trench that contains the wire, multiple wires or preformed loops.

SUBSECTION 815.81 Basis of Payment.

(page 238 English, page II.200 Metric) Add the following paragraph after the second paragraph:

The work of installing Wire Loop Installed in Roadway shall be full compensation for all labor, materials, and equipment necessary to sawcut, install the wire, multiple wires or preformed loops and seal the sawcut or trench as specified.

SUBSECTION 815.82 Payment Items.

(page II.201 Metric) Change the pay unit of item 819.832 from Meter to Each.

(pages 238 English, II.200 Metric) Delete payment items 817.70 to 817.73 and change 817.60 to 817.63 to 817.60 to 817.69.

ADDENDUM NO. 3, SEPTEMBER 9, 2014**SECTION 850****TRAFFIC CONTROLS FOR CONSTRUCTION
AND MAINTENANCE OPERATIONS****SUBSECTION 850.21 Roadway Flagger.**

(page SUPPLEMENT C2012-93) Replace this Subsection with the following:

The Contractor shall provide the number of flaggers required in either the appropriate Temporary Traffic Control Plan (TTCP) template (see MassDOT's website at <http://www.massdot.state.ma.us/>), the Temporary Traffic Control Plan or that the Engineer deems necessary for the direction and control of traffic within the site. A flagger shall be used as directed by the Engineer in accordance with 701CMR 7.00, this section, and the TTCP. Any flagger determined by the Engineer to be ineffective in controlling traffic may be removed at the discretion of the Engineer. If a flagger is directed to be removed, the Contractor shall immediately comply with the directive from the Engineer and shall suspend operations as necessary until a qualified replacement can be provided. Such a suspension of operations shall not be considered as a basis for a claim or an extension of time.

MassDOT reserves the right to provide certified Roadway Flaggers or police officers, at the discretion of the Engineer.

SUBSECTION 850.43 Safety Signing for Traffic Management.

(page SUPPLEMENT C2012-96) Add the following paragraph after the 4th paragraph of the Subsection:

Rollup signs shall be fabricated from vinyl microprismatic retroreflective material.

SUBSECTION 850.44 Temporary Pavement Markings and Temporary Raised Pavement Markers.

(page SUPPLEMENT C2012-96) Replace the first paragraph with the following:

Glass beads, tapes and paints used for temporary pavement markings shall be lead free, conform to Subsections M7.01.07, M7.01.16, M7.01.23 and M7.01.24 and meet the retroreflectivity requirements of the MUTCD for a period of 90 days. Final determination as to pavement marking quality shall be made by the Engineer. The Contractor shall supply a retroreflectometer for this purpose.

SUBSECTION 850.55 Temporary Illumination for Work Zones.

(page SUPPLEMENT C2012-99) Replace this Subsection with the following:

All floodlights shall have flat lenses securely fastened to the housing. All floodlight fixtures shall be mounted at a sufficient height to allow for an aiming angle of 45 degrees from the vertical to the job site. An inventory of spare lamps and fixtures shall be maintained on the job site and all lamp or fixture failures shall be repaired or replaced immediately.

Illumination Standards for Work Area

The entire work area shall be illuminated to a minimum average of 10 foot-candles measured on a horizontal plane 6 inches above the work surface. A uniformity ratio (average to minimum) of 4 to 1 or better shall be maintained at all times in the work area. This shall apply to the work areas only. Any area where all phases of the work are completed need not be illuminated except for the safety and transition area lighting.

Illumination Standards for Transition Areas

The transition areas are the sections of roadway where road users are redirected out of their normal path.

The traveled way within these areas and all cones, drums, or other physical barriers placed on the roadway for the purpose of channelizing or restricting vehicular traffic shall be illuminated to a minimum average of 2 foot-candles measured on a horizontal plane 6 inches above the roadway surface. A uniformity ratio (average to minimum) of 4 to 1 or better shall be maintained at all times in the transition area. These areas to be illuminated shall be defined as beginning at the first cone, drum or other physical channelizing device, continuing across the full roadway width through the transition area, and ending where the traveled way attains a constant width.

ADDENDUM NO. 3, SEPTEMBER 9, 2014**SUBSECTION 850.55 (Continued)****Lighting Equipment Mounting**

Mounting shall be designed and constructed by the contractor to suit the configuration of the equipment to which the lighting is attached.

Mounting shall be secure to prevent excessive vibration. Care shall be exercised to ensure that fixture mounting will clear all overhead structures.

All equipment lighting shall be aimed in such a manner as to maximize the illumination on each individual task.

All lighting units shall be placed in such a manner as to avoid shadows on the work area or the travel area and to prevent excessive glare to the motorist.

An inventory of spare lamps and spare fixtures shall be maintained on the job site by the contractor and all lamp or fixture failures shall be repaired or replaced immediately.

SUBSECTION 850.81 Basis of Payment.

(page SUPPLEMENT C2012-105) Replace the second paragraph with the following:

Roadway Flagger will be paid for at the contract unit price per hour which shall include full compensation for all costs for providing flaggers. No allowance or additional payment will be made for required training, equipment, travel time, transportation, or any administrative charges associated with the costs of flaggers. No allowance shall be made for overtime payment rates. The Contractor shall not be charged nor compensated for the use of MassDOT employee flaggers. This item shall not be subject to renegotiation for any reason under Section 4.06 regardless of whether or not this item overruns or underruns.

(page SUPPLEMENT C2012-106) In the 4th paragraph from the bottom of the page change "...unit price per foot (m)..." to "...unit price each..."

SUBSECTION 850.82 Payment Items.

(page SUPPLEMENT C2012-107) Change the description of payment item 854. to Temporary Raised Pavement Marker, and the description of payment item 854.5 to Raised Pavement Marker Removal.

SECTION 860 REFLECTORIZED PAVEMENT MARKINGS

SUBSECTION 860.60 Equipment.

(SUPPLEMENT C2012-108) Add the following paragraphs to the end of this Subsection:

The Contractor shall supply an infrared pistol thermometer meeting the requirements of Section 460.60 for each thermoplastic traffic marking operation on the project. The thermometers will remain the property of the Contractor upon completion of the project.

The Contractor shall supply suitable gauges for measuring the thickness of pavement markings; a digital gauge for thermoplastic lines and wet film thickness gauges for painted lines. The gauges will remain the property of the Contractor upon completion of the project.

SECTION 901 CEMENT CONCRETE

SUBSECTION 901.40 Materials.

(page SUPPLEMENT C2012-110) Replace number 1. with the following:

1. Concrete cylinder molds with plastic covers shall conform to the requirements of AASHTO M 205. The standard concrete cylinder shall be 6 inches in diameter by 12 inches high for regular Cement Concrete. When the nominal maximum size of the coarse aggregate does not exceed 1 inch, 4 inches in diameter by 8 inches high cylinders may be used.

ADDENDUM NO. 3, SEPTEMBER 9, 2014
SECTION 945
DRILLED SHAFTS

SUBSECTION 945.56 Drilled Shaft Excavation.

(page C2012-165 Supplement) Replace paragraph C. with the following:

C. Rock Socket Excavation.

Rock socket excavation is excavation that requires rock-specific tools and/or procedures to accomplish hole advancement, such as rock augers and core barrels. All excavation performed below the depth where rock socket excavation is authorized by the Engineer shall be considered rock socket excavation regardless of the density, strength, hardness, or changes in type or character of materials encountered.

ADDENDUM NO. 3, SEPTEMBER 9, 2014
DIVISION III
MATERIALS SPECIFICATIONS

SECTION M
MATERIALS

SUBSECTION M MATERIALS

*(page 327 English, page III.3 Metric) Replace the paragraphs under **Approval and Acceptance**. with the following:*

All materials must be approved prior to incorporation in the work. Approval of materials shall be in accordance with the applicable requirements of Subsection 5.03 and Section 6.00, Control of Materials. Materials may be approved at the source of manufacture or at the project site. Information regarding the origin, composition and/or manufacture of any material shall be furnished if requested by the Engineer.

Approval and acceptance of any material intended for use in the work of the Department is contingent upon the particular material conforming to a designated specification. All questions relating to materials will be resolved by the Research and Materials Section of the Department or its duly authorized representative.

The Department maintains a Qualified Construction Materials List (QCML) of commonly used materials that meet these specifications. The Qualified Construction Materials List is available at www.massdot.state.ma.us/highway.

SECTION M4
CEMENT AND CEMENT CONCRETE MATERIALS

SUBSECTION M4.02.13

(page 355 English, page III.38 Metric, page SUPPLEMENT C2012-220) Replace the last sentence of paragraph A with the following:

Slump, air content and temperature shall be measured and recorded when concrete cylinders are fabricated.

(page 355 English, page III.38 Metric, page SUPPLEMENT C2012-220) Replace paragraph B with the following:

For the purpose of making tests to determine the flexural or compressive strength of concrete, the Engineer reserves the right to cast such test beams or cylinders as he/she deems necessary.

The Contractor shall furnish concrete and such assistance as the Engineer may require.

After the fabrication of concrete cylinders by the Engineer, the concrete cylinders shall be protected and cured on the project by the Contractor in accordance with AASHTO T 23 and as directed by the Engineer without additional compensation. The Contractor shall furnish and maintain, without extra compensation, a protected environment to provide initial curing of all concrete cylinders at the project. The protective environment shall be available at each site where concrete is placed and then maintained by the Contractor until such time that all concrete cylinders have been transported to the laboratory for testing. The Engineer shall approve each protective environment prior to the beginning of any project concrete placement.

The protective environment shall be shielded from direct sunlight and radiant heating devices. The protective environment shall be capable of maintaining the temperature for the stored concrete cylinders in the range between 60 and 80°F and loss of moisture from the cylinders shall be prevented.

When moving the concrete cylinders into the protective environment, precautions shall be taken to avoid any damage to the freshly made concrete cylinders. If the top surface is marred during movement to the protective environment, refinish immediately.

The protective environment for the concrete cylinders shall consist of tightly constructed, firmly braced wooden boxes, damp sandpits, temporary building at construction sites, wet burlap covered in plastic in favorable weather, or heavyweight closed plastic bags. Other suitable methods may be used, upon approval by the Engineer, provided that the foregoing requirements limiting concrete cylinder temperature and moisture loss are met.

ADDENDUM NO. 3, SEPTEMBER 9, 2014**SUBSECTION M4.02.13** (Continued)

Storage temperature shall be regulated by means of ventilation, or thermostatically controlled cooling devices, or by using heating devices such as stoves, light bulbs, or thermostatically controlled heating elements. A temperature record of the concrete cylinders shall be established by means of maximum-minimum thermometers.

After finishing the concrete cylinders, they shall be covered and placed immediately into the protective environment where they will remain undisturbed for the initial curing period.

Concrete cylinders that are to be transported to the laboratory for standard curing before 48 hours shall remain in the molds in a moist environment until they are received in the laboratory, demolded and placed in standard curing. Concrete cylinders that will be transported to the laboratory for standard curing after 48 hours age may be cured in the protective environment provided that the loss of moisture is prevented until the time of transportation and testing. Concrete cylinders shall be demolded no later than 48 hours.

28-day and 56-day concrete cylinders shall be transported to the laboratory for standard curing and testing by the Department personnel within six days of the time of cylinder fabrication. 7-day cylinders shall be transported to the laboratory as soon as possible but not until at least 8 hours after final set (Setting Time may be measured by AASHTO T197).

When the sequence of the construction operation is dependent upon the development of strength in concrete previously placed the specimens taken for this purpose shall be further cured after 24 hours as required in Section 9 of AASHTO T 23 by the Contractor, without additional compensation, under the direction of the Engineer

(page SUPPLEMENT C2012-221) Replace paragraph F with the following:

F. Individual strength tests shall not fall below the specified strength (f'_c) by more than 500psi (3.5 MPa). If the 28-day cylinder breaks fail to meet the specified strength, 56-day cylinder breaks shall be accepted as proof of reasonably close conformity with the specification. If the 56-day cylinder breaks fail to meet the specified strength, the Contractor may request permission to core the concrete to verify its strength. Coring may only be done with the permission of the Department, at locations chosen by the Department and within 2 weeks of being notified that the 56-day cylinder breaks have failed. The Department shall specify a minimum of 3 core locations. Core results shall be evaluated in accordance with ACI procedures whereby the average of all core breaks must exceed 85% of the specified design strength and no single core break may be less than 75% of the specified design strength. The Contractor may request permission to core the concrete immediately after the failure of 28-day cylinder breaks, rather than waiting for 56-day cylinder tests, if waiting for later tests will compromise the project's schedule. All concrete represented by the compression test that indicates a compressive strength of more than 500 psi below the specified 28-day strength will be rejected and shall be removed and replaced with acceptable concrete. However, the Contractor may, at his own expense, obtain and submit evidence as outlined below, acceptable to the Engineer, that the strength and quality of the concrete placed in the work is acceptable, then the concrete will be permitted to remain in place and the contractor will be paid at a reduced price as outlined below.

ADDENDUM NO. 3, SEPTEMBER 9, 2014**SUBSECTION M4.02.13 (Continued)**

(page SUPPLEMENT C2012-221) Replace paragraph H with the following:

H. Evaluation and Acceptance of Concrete.

The strength of the concrete will be considered satisfactory provided that the average of all sets of three consecutive test results of the same concrete mix equal to or exceed the required specified strength f_c , and no individual test result falls below the specified strength f_c by more than 500 psi (3.5 MPa).

Non-destructive testing will not be permitted in lieu of compressive strength tests of concrete cylinders, air content tests by the pressure method, slump or other test for evaluation and acceptance on concrete placed on the projects. Coring is the only acceptance method to determine the in-situ characteristics of concrete. The size of the core shall be 4-inch (100 mm) finished diameter for concrete with $\frac{3}{4}$ inch (20 mm) or less aggregate and 6-inch (150 mm) finished diameter for concrete with aggregate greater than $\frac{3}{4}$ inch. The length of the concrete core, when capped, shall be as nearly as practicable twice its diameter and a strength correction factor in accordance with AASHTO T 24 must be determined based on the ratio of Length to Diameter (L/D). Cores with L/D ratio less than 1 shall not be tested. Wipe off the surface of the drilled cores and allow the remaining surface moisture to evaporate. When the surfaces appear dry but not more than an hour after drilling, place cores in separate plastic bags or non-absorbent containers and seal to prevent moisture loss. Allow the cores to remain in the sealed plastic bags or non-absorbent containers for at least 5 days after last being wetted before making the compression test.

A request for strength analysis by coring shall be approved by the Engineer prior to beginning the work. Coring will not be permitted if the Department determines it would be harmful to the integrity of the structure. Cores shall be obtained by the Contractor and witnessed by the Engineer in accordance with AASHTO T 24 and delivered to Research and Materials for testing in accordance with AASHTO T 22. The test results will be considered proof of in-situ concrete strength and will supersede all other strength data for the concrete represented by that placement. Cores shall be obtained no later than two weeks after the 56 day cylinder breaks have failed. All reinforcing steel shall be located with a pachometer around the proposed coring locations prior to the coring operation. The Department shall approve the location to be cored. And all cost associated with the coring operation including the repair of cored area shall be the responsibility of the contractor. The Contractor shall patch the core holes with low slump mortar, similar to that used in the concrete, immediately after coring, to the satisfaction of the Engineer. Acceptance by core method requires that the average compressive strength of three cores from the same concrete placement exceeds 85 percent of the specified design strength with no single core less than 75 percent of the specified design strength.

These cores may be subjected to petrographic analysis, if deemed necessary by the Engineer and at the expense of the Contractor, to determine if there is microscopy evidence that identifies the constituents of concrete, possible reasons for the strength deficiency of the in-situ concrete, if any, and to provide a basis for assessing the quality and long term durability of the in-situ concrete. The results of the petrographic analysis will be considered in conjunction with the results of concrete cylinders to determine if the concrete can remain in place or has to be removed.

Concrete that meets the strength requirements through the 28 day, the 56 day break or the core break shall be considered in reasonably close conformance with the specifications and no credit shall be taken.

Concrete with cylinder or core compressive strength (f_c) which fails to meet acceptance level requirements shall be evaluated for structural adequacy at the Contractors' expense. The Department shall review all production records, the concrete test records, petrographic analysis report, field notes, and the placement records for the concrete in question. If the Engineer determines the material is found to be adequate to remain in place, payment shall be adjusted in accordance with the following formula:

$$\text{Pay adjustment for substandard concrete, } P = 2(f_c - \bar{f}_c)(UP)(Q)/(\bar{f}_c)$$

Where \bar{f}_c = Specified minimum compressive strength at 28 days

f_c = Substandard concrete cylinder compressive strength at 28 days or compressive strength of substandard concrete cores determined by AASHTO T22.

P = pay adjustment for substandard concrete.

Q = Quantity of concrete represented by the acceptance cylinders tested.

UP = Unit contract price or the lump sum breakdown price per cubic yard for the class of concrete involved complete in place.

ADDENDUM NO. 3, SEPTEMBER 9, 2014**SECTION M8
METALS AND RELATED MATERIALS****SUBSECTION M8.03.0 Iron Castings.**

(page SUPPLEMENT C2012-242) Replace this Subsection with the following:

Gray Iron Castings shall conform to the requirements of AASHTO M 105, Class 35B. Test bars shall conform to the requirements of tension test specimen B with a minimum of 1 in thread on each end. The thread size shall be 1 1/8 in – 7 UNC. Ductile Iron Casting for double grates shall conform to the requirements of ASTM A536 Grade 80-55-06 unless otherwise specified. Test bars shall conform to the requirements of standard round tension specimen (2 in gage length) with a minimum of 1 in thread on each end. The thread size shall be 7/8 in -9 UNC.

All iron castings shall conform to the requirements of AASHTO M306 and shall be manufactured true to pattern in form and dimensions, free from pouring faults, cracks, blow holes and other defects affecting their strength and value for the service intended. The casting shall be boldly filleted at angles and the arises shall be sharp and perfect. The surfaces shall have a workmanlike finish.

**SECTION M9
MISCELLANEOUS MATERIALS****SUBSECTION M9.30.0 Reflective Sheeting.**

(page 407 English, page III.97 Metric, page SUPPLEMENT C2012-261) Replace the entire Subsection with the following:

This specification covers retroreflective sheeting designed to reflectorize traffic control signs, delineators, barricades, and other devices. All reflective sheeting shall meet the requirements of ASTM D4956 and AASHTO M268, and as listed below:

High Intensity (H/I) Sheeting for permanent traffic signs shall conform to ASTM Type III or IV.

High Intensity Prismatic (HIP) Sheeting for permanent traffic signs and temporary rigid construction signs shall meet or exceed the requirements of ASTM Type VIII.

Flexible High Intensity (H/I) Sheeting for drums, cones, and barricades shall conform to ASTM Type VI.

Flexible High Intensity Prismatic (HIP) Sheeting for rollup signs shall conform to ASTM Type VI.

*** END OF SECTION ***

③ADDENDUM NO. 3, SEPTEMBER 9, 2014**CONTRACTUAL MILESTONES** (Supplementing Subsection 8.03)

This Contract contains the following Contractual Milestones that are to be included in the Contractor's Baseline Contract Progress Schedule submission. The Contractor shall identify the completion of the work pertaining to each Contractual Milestone through the inclusion of a Finish Milestone in the Baseline Contract Progress Schedule.

To ensure that the Contractor performs the Project on schedule, MassDOT has established the following three (3) milestones defined as follows: **Contractual Milestones:**

- ③ **Milestone #03 – Washington Avenue Bridge - One lane open in Northbound direction:** The Contractor shall achieve Completion within **449 Calendar Days from the date the Washington Avenue Bridge is closed to traffic**. Contractor Completion for Milestone #03 is defined as the completion of all physical contract work required so that Washington Avenue may be opened to one-way traffic in the Northbound direction.

Milestone #02 – Full Beneficial Use & Substantial Completion of the Washington Avenue Bridge and Full Operation of the Busway: The Contractor shall achieve Full Beneficial Use & Substantial Completion within **700 Calendar Days from Notice to Proceed**. Contractor completion for Milestone #02 is defined as the complete demolition of the existing bridge structure, completion of the roadway approach work, and full completion of the new Bridge open to two-way traffic with both sidewalks open to pedestrians; full operation of the busway including fully operational Bus Rapid Transit Stations and shared use path further defined as follows:

Full Beneficial Use: The majority of Contract Work has been completed and the asset(s) has been opened for full multi-modal transportation use, except for limited contract work items that do not materially impair or hinder the intended public use of the transportation facility. All anticipated lane takings have been completed and removed, except for minor, short term work items.

Substantial Completion: A walkthrough of the entire Contract Work has been performed by the Resident Engineer, a Punchlist has been generated and the Work required by the Contract, including paperwork, has been completed, except for work having a contract price of less than one percent of the adjusted total contract price, including overruns, underruns and all contract amendments. All material submittals have been received by the District Materials Lab.

Milestone #01 – Contractor Field Completion: The Contractor shall achieve Contractor Field Completion within **728 Calendar Days from Notice to Proceed**. Contractor completion for Milestone #01 is defined as completion of Milestones #03 and #02 and all punch list work.

Contractor Field Completion: All physical Contract Work is complete including punch list. The Contractor has fully de-mobilized from field operations.

③ADDENDUM NO. 3, SEPTEMBER 9, 2014**INCENTIVE/DISINCENTIVE REQUIREMENTS**

For the purposes of this Contract, MassDOT is instituting a No Excuse Incentive/Disincentive Clause for Milestone #03 and Milestone #02. There will be no incentive or disincentive associated with Milestone #01. This specification is intended to encourage the Contractor to use innovative methodologies to achieve early completion of key milestones. To encourage such innovation, keep daily road user costs (DRUC) at a minimum, and minimize disruption to adjacent neighborhoods and businesses, MassDOT is proposing the following incentive/disincentive provisions.

Incentive/Disincentive for Milestone #03

- ③ Incentive Payments: If the Contractor successfully achieves Milestone #03 as defined above before **449** Calendar Days from **the date the Washington Avenue Bridge is closed to traffic**, MassDOT shall pay an Incentive Payment of \$18,000.00 per Calendar Day. The Maximum Incentive Amount shall not exceed \$1,764,000.00 and 98 Calendar Days.

Disincentive Deduction: Conversely, if the Contractor achieves Milestone #03 later than **449** Calendar Days from the Notice to Proceed, MassDOT shall assess the Contractor a Disincentive Deduction of \$18,000.00 per Calendar Day. The maximum Disincentive amount shall not exceed \$1,764,000.00 and 98 Calendar Days.

Incentive/Disincentive for Milestone #02

Incentive Payments: If the Contractor successfully achieves Milestone #02 before **700** Calendar Days from Notice to Proceed, MassDOT shall pay an Incentive Payment of \$8,500.00 per Calendar Day. The maximum Incentive amount shall not exceed \$824,500 and 97 Calendar Days.

Disincentive Deduction: Conversely, if the Contractor achieves Milestone #02 later than **700** Calendar Days from the Notice to Proceed, MassDOT shall assess the Contractor a Disincentive Deduction of \$8,500.00 per Calendar Day. The maximum Disincentive amount shall not exceed \$824,500.00 and 97 Calendar Days.

Time Extensions

The Engineer shall determine time extensions in accordance with Subsection 8.10 of the Standard Specifications, Determination and Extension of Contract Time for Completion. There shall be no other basis for extension of time other than as provided in Subsection 8.10 of the Standard Specifications.

For purposes of determining whether the Contractor shall receive an Incentive Payment, the number of Calendar Days set forth in Milestone #03 and #02 will not be adjusted under any circumstances for any reason, cause, or circumstance whatsoever, regardless of fault, save for and except in the instance of a catastrophic event and/or declared state of emergency.

PROTECTION OF UTILITIES AND PROPERTY (Supplementing Subsection 7.13)

The Contractor, in constructing or installing facilities alongside or near sanitary sewers, storm drains, water or gas pipes, electric or telephone conduits, poles, sidewalks, walls or other structures, shall, at his expense, sustain them securely in place, cooperating with the officers and agents of the various utility companies and municipal departments which control them, so that the services of these structures shall be maintained. He shall also be responsible for the repair or replacement, at his own expense, of any damage to such structures caused by his acts or neglect, and shall leave them in the same condition as they existed prior to the commencement of work. In case of damage to utilities, the Contractor shall promptly notify the Owner and shall, if requested by the Engineer, furnish laborers to work temporarily under the Owner's direction in providing access to the utility. Pipes or other structures damaged by the operation of the Contractor may be repaired by the City of Chelsea, or by the utility company which suffers the loss. The cost of such repairs shall be borne by the Contractor, without compensation therefore.

If, as the work progresses, it is found that any of the utility structures are so placed as to render it impracticable, in the judgment of the Engineer, to do the work called for under this Contract, the Contractor shall protect and maintain the services in such utilities and structures and the Department will, as soon thereafter as it reasonably can, cause the position of the utilities to be changed or take such other action as it deems suitable and proper.

Full compensation for furnishing all labor, materials, tools, equipment and incidentals and for doing all the work involved in protecting or repairing property as specified in this Section shall be considered as included in the prices paid for the various contract items of work and no additional compensation will be allowed therefore.

The Contractor will cooperate fully with all utility companies private or public, and will notify all such companies at least forty-eight hours prior to excavating in the vicinity of any utility. It is understood that the Contractor has considered in his bid the existence of the various utilities and that no additional compensation will be allowed for any delays, inconvenience, or damage sustained by him due to any interference by said utilities, unless said compensation is authorized in writing by the Engineer as specified under Subsection 4.03 for Extra Work.

For utility connections, the serving utility will make any required connections to the power source. The Contractor shall supply all labor, materials and equipment to install the service connections, complete in place and in accordance with National Grid procedures. Enough wire shall be coiled within the electric manholes/handholes serving utility to make the final connection.

The Contractor shall pay the serving utility for their services rendered for the connection of the service connections.

The Contractor shall, at his own expense, preserve and protect from injury and damage the existing building at 63 Washington Avenue, and he shall be responsible for a repair at his own expense any and all damage and injury thereto, arising out of or in consequence of his execution of the work, or in consequence of non-execution thereof by the Contractor or his employees or Subcontractors in the performance of the work covered by the Contract prior to completion and acceptance of thereof.

③ ADDENDUM NO. 3, SEPTEMBER 9, 2014**PROTECTION OF UTILITIES AND PROPERTY** (Continued)

Contractor shall conduct a pre-construction building condition survey, perform geotechnical instrumentation and monitoring, and conduct a post-construction building condition survey for the 63 Washington Avenue building as required in Special Provision Item 100.91, Pre and Post Construction Survey Geotechnical Instrumentation and Monitoring – Site 1.

- ③ The Contractor shall be aware of existing fiber optic cable lines running generally under the proposed busway from Mystic Mall Station to a point just east of Broadway. Portions of these lines are owned by Bell Canada and are part of the Transatlantic Cable Network. Contractor shall take extra caution in working around these lines and shall excavate test pits for identifying exact locations utilizing a vacuum truck. Contractor shall protect in place **and encase in concrete** as directed by the Engineer.

DRAINAGE (Supplementing Subsection 7.13)

It shall be the Contractor's responsibility to maintain the temporary drainage system within the project limits as defined by the Engineer. The Contractor will maintain positive drainage within the project limits (and the immediate vicinity) at all times throughout the construction phase.

It shall be the responsibility of the Contractor to make certain that all drainage systems, either new or existing, that carry drainage run-off from the limits of this project operate efficiently to their point of discharge.

Pipes and structures requiring cleaning as a result of accumulations from the construction operations shall be cleaned without additional compensation

The castings of all structures, which are required to be set or reset under this project, shall not be set complete in place to the final grade until after the bituminous concrete binder course has been completed and top course is scheduled to be completed with 2 weeks.

Before placement of top course material begins, utility structures shall be adjusted to final grade. Utility structures shall be exposed above binder grade for not more than two (2) weeks before placement of top course material will be required. All Catch Basin structures shall be set flush with finish grade.

All the above work shall be included under the relevant drainage item without additional compensation therefore. Any adjustments made to new drainage structures will be included under the contract unit price for the respective structures.

③ ADDENDUM NO. 3, SEPTEMBER 9, 2014**INSURANCE REQUIREMENTS** (Supplementing Section 7.05)

The insurance requirements set forth in this section are in addition to the requirements of the Standard Specifications and supercede all other requirements .

③ RAILROAD PROTECTIVE INSURANCE

Railroad Protective Liability Insurance and Protective Property Damage Liability Insurance shall be obtained b the Contractor in the amount of **\$5,000,000/\$10,000,000**, on behalf of the **MBTA, the Operating Railroad, CSXT and PanAm**.

Railroad Operations Directorate: Section F:

Railroad Protective Insurance(Required if work is performed within 50 feet of railroad track).

1. The Contractor shall furnish, with respect to the operations of the Contractor or any of the Contractor's Subcontractors performing within the Railroad right-of-way, broad form Railroad Protective Liability Insurance covering all work performed under this Contract in the amount of not less than \$6,000,000 per occurrence, \$10,000,000 aggregate combined bodily injury and property damage.
2. Such insurance shall be written on an occurrence basis.
3. The MBTA and applicable railroads shall be the named insureds on such insurance.
4. The Contractor shall furnish to the MBTA and railroad companies a signed original of the Railroad Protective Liability Policy prior to entry upon the railroad right-of-way.
5. Such policies shall provide 30 days notice to each named insured by the insurance company before any change or cancellation of the policies.
6. Such Railroad Protective Insurance policies may be provided in forms commonly referred to as AAR/AASHTO or ISO/RIMA but not Oregon.

Questions regarding insurance should be directed to the MBTA's Risk Manager at 617-222-3064.

The contractor shall be aware of the latest MBTA insurance limits / requirements. See the following link for more information:

<http://www.transitrealty.com/licenses/>

CONCRETE WORK

The various classes of concrete shall conform to the applicable requirements of Section 901 of the standard Specifications with the following conditions. Where the Contractor is given the option of cast-in-place concrete or precast units, the steel reinforcements shall be the same, whichever is used. If a lifting hook is required for a precast unit, it shall be so placed that it will neither cramp the space for work to be done within the unit nor appear on the exposed surface of the completed work. Surfaces that will be exposed in the completed work shall be finished with a wood float.

All concrete forms except sheeting, whether below or above grade, shall be removed. Steel reinforcement shall conform to the applicable provisions of Subsection M8.01.0 of the standard Specifications, except that bars used for pulling irons shall be plain bars without deformation. Where anchor bolts are to be embedded in concrete, the embedment shall be made in accordance with the bolt circle template acquired from and furnished by the manufacturer of the item to be anchored. The bolt location must be oriented to place the item in the required position with respect to the street and the intent shown on the Contract Plans.

PERMITS AND LICENSES (Supplementing Subsection 7.03)

Before any electrical connections are made the Contractor shall submit a copy of the master electrician's license who is an owner of the company that will do the work on the project, copies of the current licenses of all electricians who will perform the electrical work. Within ten (10) days after opening of bids, the low bidder shall submit a list of the Journeyman Electricians (MA license) who will perform the electrical work in this contract, along with copies of each Journeyman Electrician's current Massachusetts license.

The Contractor will also be required to obtain a Building Permit from the Commonwealth of Massachusetts Department of Public Safety, Division of Inspections. MassDOT and the Designers will assist in the preparation of the building permit application.

NPDES CONSTRUCTION GENERAL PERMIT

A Notice of Intent for coverage under the general permits shall be filed with the United States Environmental Protection Agency (EPA)/MA DEP in accordance with the NPDES permit program. It is the Contractor's responsibility to be aware of and comply with the applicable restrictions and requirements and plan his/her work and schedule accordingly.

The Contractor is advised that no additional compensation will be allowed for work required to establish, achieve, and maintain compliance with the NPDES permit program, as payment for the work shall be included in Item 756, NPDES Storm Water Pollution Prevention Plan, as appropriate.

ITEM 486.1 SCORED CEMENT CONCRETE PAVEMENT SQUARE YARD

The work under this Item shall conform to the relevant provisions of Section 476 of the Standard Specifications and the following:

The work shall consist of a scored cement concrete pavement composed of air entrained Portland cement concrete as specified, constructed on an approved foundation in accordance with the Standard Specifications and these Special Provisions. The pavement shall be installed at locations indicated on the plans and as directed by the Engineer.

The scored concrete pavement shall consist of a 10 inches of cement concrete pavement over 4 inches of dense graded crushed stone over 8 inches of gravel borrow.

MATERIALS

Cement concrete shall 5000 psi – ¾” – 705 lbs/cy.

CONSTRUCTION METHODS

Scored Cement Concrete Pavement shall be constructed in accordance with Section 476 of the Standard Specifications and the Massachusetts Department of Transportation Highway Division “Construction Standard Details” (Refer to Drawing No. E 105.2.0 for specific details).

METHOD OF MEASUREMENT AND BASIS OF PAYMENT

Item 486.1 will be measured and paid for at the Contract Unit Price per SQUARE YARD, complete in place. The cost for this work shall include full compensation for, all labor, equipment, materials and any incidentals required to complete work to the satisfaction of the Engineer.

ITEM 490.01 RAILROAD GRADE CROSSING RECONSTRUCTION LUMP SUM

Work under this Item shall include all materials, labor and equipment needed to reconstruct railroad grade crossings, and reconstruct and relocate railroad signal systems as part of the Proposed Silver Line Gateway Project in Chelsea, as indicated on the Plans and as specified herein.

The work under this Item shall conform to the applicable provisions of the MBTA Specifications included in Document A00804 - Appendix B of these Special Provisions.

The Railroad Track and Signals Systems Work consists of improvements to the existing tracks and signal systems at Spruce Street on the East Route (Rockport/Newburyport Commuter Rail Line) to support the construction of the Silver Line busway. The work includes but not limited to, track construction, grade crossing rehabilitation, removal of automatic signal locations, track surfacing & alignment, and the retirement or demolition of existing track and signal system elements.

③ ADDENDUM NO. 3, SEPTEMBER 9, 2014**ITEM 490.01** (Continued)

These improvements will be made while the existing East Route Commuter Rail Line maintains revenue passenger and freight service except for select weekend service shutdowns. The Track and Signals Systems Work shall be done in accordance with the Massachusetts Bay Transportation Authority (MBTA) Standard Specifications attached as Document A00804 - Appendix B.

The work shall also be performed in accordance with the following MBTA Standard Documents:

- The MBTA Railroad Operations Commuter Rail Material Specifications
- The MBTA Railroad Operations Directorate Specifications Guidelines
- The MBTA Commuter Rail Design Standards Manual Volume 1 Section 1 – Track and Roadway
- The MBTA Commuter Rail Book of Standard Plans Track and Roadway Section 1
- The MBTA Commuter Rail Book of Standard Plans Track and Roadway Section 2;
- and the Plans, Special Provisions and Supplemental Specifications herein.

SUBMITTALS

The Contractor shall submit to the Engineer, representative samples, certifications, manufacturer's literature and certified test results for materials to be used under this item. Submit detailed Shop Drawings for the various components of the Trackwork, Grade Crossings and Signal Systems as indicated in Document A00804 - Appendix B.

MATERIALS

Refer to Supplemental Specifications in Document A00804 - Appendix B.

CONSTRUCTION METHODS

Refer to Supplemental Specifications in Document A00804 - Appendix B.

METHOD OF MEASUREMENT AND BASIS OF PAYMENT

Separate measurement and payment will not be made for the work under this item, but all costs in connection therefore shall be included in the Contract LUMP SUM Price for Item No. 490.01 – Railroad Grade Crossing Reconstruction. The LUMP SUM price shall include all materials, labor, tools and equipment incidental and necessary for the installation complete in place, of the track work, grade crossing reconstruction, and signal system upgrades including all associated Electrical Work, **testing and acceptance.**

③

③ ADDENDUM NO. 3, SEPTEMBER 9, 2014**ITEM 629.2 PRECAST CONCRETE MEDIAN BARRIER – DOUBLE FACED FOOT**

Work under this Item shall conform to the relevant provisions of Section 629 of the Standard Specifications and the following.

The work under this item consists of furnishing and installing Precast Concrete Barriers, **and Pre-Cast Concrete Barrier Transition Sections** complete in place, as indicated on the Contract Documents. The work includes the F-Shape Concrete Barrier with 4-foot fence and the F-Shape Asymmetrical Concrete Barrier with 4-foot Fence.

The 4-foot fence shall conform to the relevant provisions of Section 644.

Concrete barrier transition sections shall conform to the relevant provisions of Section 901.

METHOD OF MEASUREMENT AND BASIS OF PAYMENT

- ③ F-Shape and F-Shape Asymmetrical **Concrete and Transition** Barriers will be measured and paid for at the Contract Unit Price per FOOT under ITEM 629.2. Said price shall include all labor, material and equipment to furnish and install the barriers, complete in place.

The 4-foot fence will be measured and paid for under Item No. 644.148.

Concrete barrier transition sections will be measured and paid for under Item No. 901.

<u>ITEM 657.</u>	<u>TEMPORARY FENCE</u>	<u>FOOT</u>
<u>ITEM 657.5</u>	<u>TEMPORARY FENCE REMOVED AND RESET</u>	<u>FOOT</u>

The work to be done under these Items shall be in accordance with Sections 644 and 655 of the Standard Specifications and shall consist of furnishing, installing, relocating and final removal of the temporary fence and gates. Location of temporary fence and gates shall be as shown on the plans or as directed by the Engineer. Fence shall be relocated as required during different stages of construction.

The intent of this item is to prevent access to the work area of the new bridge by unauthorized individuals and to protect the safety of personnel and the general public.

The temporary fence shall be a minimum of six (6) feet in height and shall be any type specified in Section 644. All end, corner, gate and intermediate posts shall be driven into the ground and properly supported as outlined in Section 644. Fence post shall not be inserted into the bridge deck. Fence within the bridge shall be installed on top of the temporary concrete barrier. Where temporary chain link fence is required on top of the temporary concrete barriers, the fence posts shall be 2 3/8 inches O.D., galvanized Schedule 40 and 3 feet minimum in height.

The Contractor shall be responsible for maintenance of the temporary fence, and shall be responsible and cognizant that it remains secure and that the area is sealed off to the general public at all times. Fence fabric shall be placed on the face of the post away from the work area. The top edge of the fabric shall be finished with a "knuckled" selvage.

ITEM 657 and ITEM 657.5 (Continued)

During construction it will be necessary to remove and reset the temporary fence at different locations to accommodate the stage construction.

The cost for all end, corner and intermediate brace posts as well as brackets and hardware for attaching fence to concrete barrier and all other incidental materials, labor and equipment required for the installation, including concrete foundations if required, relocation and final removal shall be included under the Contract unit bid price per foot. Material need not be new, but shall not be deteriorated, nor in any way jeopardize the protection purposes intended. All fencing shall meet the approval of the Engineer.

BASIS OF PAYMENT

Payment for ITEM 657. TEMPORARY FENCE shall be at the Contract price per FOOT, complete in place, with twenty (20) percent of the bid price held until the fence is removed. Said price shall include full compensation for all labor, tools, materials and equipment necessary for the installation, maintenance and removal of the fencing. Upon removal all materials shall become the property of the Contractor.

Payment for ITEM 657.5, TEMPORARY FENCE REMOVED AND RESET shall be at the Contract unit price per Foot, complete in place, which price shall include all labor, material and equipment to remove and reset the chain link fence as required for the various stages of construction after the initial installation or as required by the Engineer.

ITEM 657.1**TEMPORARY PEDESTRIAN MGMNT.
GUIDANCE SYSTEM****FOOT**

Work to be done under this item shall consist of installing a system to guide pedestrians around closed sidewalk locations where no current barriers to access exist and that are on the same side of the roadway. Pedestrian Detours that route pedestrians to the opposite side of the street will be paid under Item 851.1 Traffic Cones for Traffic Management.

Elements of the system may include barricade, temporary concrete barrier, temporary concrete barrier with pedestrian rail, temporary curb ramps and associated modifications and appurtenances and signage. The guidance system is to prevent pedestrians from entering the work area, protect pedestrians from vehicles entering a shoulder area temporarily designated for pedestrian use around the work site, and prevent pedestrians from leaving the temporary path and entering the vehicle lane.

Prior to deploying the Temporary Pedestrian Management Guidance System the Contractor shall prepare a sketch plan of the system for the work site showing the barrier system, the width of the path of travel, the locations and types of signs and the locations of temporary pedestrian curb ramps. This will be reviewed and approved by the Engineer prior to its set up. Any material that is damaged during the deployed period and throughout the project shall be replaced at the directions of the Engineer at no additional cost.

③ ADDENDUM NO. 3, SEPTEMBER 9, 2014**ITEM 657.1** (Continued)

Layout must meet the requirements of the ADA and the Massachusetts AAB as well as the rules and regulations for traffic control devices and the 2009 Manual on Uniform Traffic Control Devices (MUTCD). All material which is used adjacent to traffic must meet the requirements of NCHRP350 or MASH. The guidance system must have a continuous bottom rail or edge no more than two (2) inches above the ground to accommodate cane users, have a smooth and continuous top edge no less than 32 inches above the ground to facilitate "hand trailing" and not obstruct or project into the pedestrian path of travel. All elements of the pedestrian guidance system should be nearly vertical and generally within the same plane.

Supplemental information, included with this contract, of some elements of a pedestrian management guidance system should be considered as examples of types of elements which may be used to construct, and not as recommended, required, or the only elements which are acceptable. All pieces bought or constructed by the Contractor, which meet ADA and Massachusetts AAB requirements are acceptable.

METHOD OF MEASUREMENT AND BASIS OF PAYMENT

ITEM 657.1, TEMPORARY PEDESTRIAN MGMNT. GUIDANCE SYSTEM, will be measured by the FOOT of temporary pedestrian route as approved in the sketch plans. The Payment shall be full compensation for providing barriers of various types, signs, temporary curb ramps, associated modifications to the site and all appurtenances. The Contractor must provide sufficient barriers of various types requires for each active construction location. Payment will include the cost of first set up, maintenance throughout the construction, and final removal and completion of the work at the site.

**ITEM 657.11 TEMPORARY PEDESTRIAN MGMNT. GUIDANCE SYSTEM FOOT
REMOVED AND RESET**

Work to be done under this item shall consist of removing and resetting the pedestrian guidance system placed at specific work locations as required by the Engineer.

It is the intent of this item to reuse the placed pedestrian guidance system in many locations. The Contractor shall maintain the integrity of the guidance system throughout the project duration. Special care shall be taken by the Contractor removing and resetting of the guidance system not to damage any piece of the system. The system shall remain in working order throughout the construction. There shall be no compensation made for any damaged section that occurred while performing Item 657.11.

METHOD OF MEASUREMENT

- ③ ITEM 657.11, TEMPORARY PEDESTRIAN MGMNT. GUIDANCE SYSTEM REMOVED AND RESET shall be measured per FOOT, completely removed and reset and accepted by the Engineer.

ITEM 657.11 (Continued)**BASIS OF PAYMENT**

ITEM 657.11, TEMPORARY PEDESTRIAN MGMNT. GUIDANCE SYSTEM REMOVED AND RESET shall be paid for at the Contract unit price per foot as measured by the Engineer. The price shall include full compensation for removing and resetting the guidance system and placing all materials including work necessary for final completion of the item as specified.

ITEM 660.1**METAL PIPE RAIL REMOVED AND DISCARDED****FOOT**

Work under this Item shall conform to the relevant provisions of Section 665 and shall consist of the removal of the existing iron fence rail, posts, bracing and hardware at the location shown on the plans for offsite disposal.

METHOD OF MEASUREMENT AND BASIS OF PAYMENT

ITEM 660.1, METAL PIPE RAIL REMOVED AND DISCARDED shall be measured per FOOT, measured in its original location.

ITEM 660.1, METAL PIPE RAIL REMOVED AND DISCARDED will be paid for at the Contract Unit Price per FOOT; which price shall include all labor, material and equipment to remove the iron fence, including posts, bracing and hardware, and dispose of it off site.

ITEM 669.1**CHAIN LINK FENCE REMOVED AND DISCARDED****FOOT**

Work under this Item shall conform to the relevant provisions of Section 665 and shall consist of the removal of the existing chain link fence, posts, bracing and hardware at the locations shown on the plans for offsite disposal.

METHOD OF MEASUREMENT AND BASIS OF PAYMENT

ITEM 669.1, CHAIN LINK FENCE REMOVED AND DISCARDED shall be measured per FOOT, measured in its original location.

ITEM 669.1, CHAIN LINK FENCE REMOVED AND DISCARDED will be paid for at the Contract Unit Price per FOOT; which price shall include all labor, material and equipment to remove the chain link fence, including posts, bracing and hardware, and dispose of it off site.

③ ADDENDUM NO. 3, SEPTEMBER 9, 2014**ITEM 804.3****3-INCH ELECTRICAL CONDUIT**
TYPE NM - PLASTIC (UL)**FOOT**

The work under this Item shall conform to the relevant provisions of Section 800 of the Standard Specifications and the following:

- ③ The work shall include the furnishing and installation of the 3-inch non-metallic conduit supplying power to the busway and BRT station lighting systems **and the Traffic Control Systems**, in accordance with the plans and as directed by the Engineer. The conduit material shall be Schedule 80 polyvinyl chloride (PVC) plastic conduit. The conduit quantity may be increased or decreased by the Engineer depending upon actual conditions encountered as provided for in Section 4.06 of the Standard Specifications.

Conduit in Grass or in Planted Areas

Where new conduits are installed in grass and planted areas, work shall include placement of a minimum of 4 inches of loam borrow, seed and any other materials replaced in kind to restore disturbed areas to their original condition. Any existing plants (bushes, flowers, etc.) removed or damaged as a result of this project shall be replaced in kind. Loam and seeding shall be measured and paid for under their respective items.

Conduit under Sidewalk or Median Driveways

Where conduit is installed in sidewalk or paved median or asphalt driveway areas, the work shall include excavating and backfilling of trenches, including necessary compaction. Payment for cement concrete or asphalt pavement shall be paid for under the respective item.

Conduit Crossing Roadways

Trenches in existing asphalt pavements not subject to full depth reconstruction shall be sawcut to an 18 inch width. The existing pavements shall be sawcut through their full depth and the pavement removed.

After conduit installation, the trench shall be backfilled with controlled density fill (CDF) **as directed**. CDF shall be Type 2E and shall be as specified in Section M4.08.0 of the Standard Specifications. The finished grade of the CDF shall be below existing pavement surface as shown on the construction details. CDF shall be paid under its respective item.

- ③ **The main power supply 3" PVC conduit along the entire busway shall be encased in concrete as indicated on the Plans.** All conduit shall be installed with a detectable metallic warning tape in accordance with the revised standard drawings for traffic signals.
- ③ ITEM 804.3 will be paid for at the Contract Unit Price per FOOT and shall include all labor, material and equipment necessary to install the main power supply for the busway and BRT Station lighting systems **and the traffic control systems**. No separate payment shall be made for the sawcutting, excavation, backfill, conduit, wiring, concrete ductbank and all other incidentals to complete the work, but all costs in connection therewith shall be included in the contract unit price for ITEM 804.3.

<u>ITEM 806.41</u>	<u>4 INCH ELECTRICAL CONDUIT – TYPE RM</u> <u>(SPLIT GALVANIZED STEEL)</u>	<u>FOOT</u>
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Work under this item shall be in conformance with the Verizon standards included in the Appendix and the following:

The work consists of furnishing and installing split galvanized steel conduit sleeves for the existing telephone conduit attached to the bridge.

The split galvanized steel conduit sleeves shall be sized to fit the outside diameter of the existing conduit. The split galvanized steel conduit sleeves shall have two interlocking sections that securely attach to each other around the existing conduit. The Contractor shall verify the size of the existing conduit and submit shop drawings of the split galvanized steel conduit sleeve for approval prior to ordering the materials.

All couplings, fittings and clamps needed to connect the split galvanized steel conduit sleeve to the existing conduit shall be included in the cost of this item.

The conduit shall be measured and paid by the foot of conduit installed including all couplings, fittings, clamps and all miscellaneous materials necessary to complete the installation.

ITEMS 815.1 thru 815.4 (Continued)Keys

Two controller cabinet door keys and police door keys shall be supplied for each controller cabinet on the project.

Traffic Signal LED Module

All signal and pedestrian displays shall be equipped with LED signal modules. All red, amber, green, and pedestrian signal housings with the exception of optically programmed and fiber optic housings and shall conform to the following where applicable:

- ITE's Vehicle Traffic Control Signal Heads – Light Emitting Diode (LED) Arrow Traffic Signal Supplement, Dated April 3, 2006.
- ITE's Vehicle Traffic Control Signal Heads – Light Emitting Diode (LED) Circular Signal Supplement, Dated June 27, 2005.
- ITE's Pedestrian and Countdown Signal Modules Compliant to PTCSI - Part 2 Light Emitting Diode (LED), Dated, August, 2007.
- Energy Star / EPACT Program Requirements for Traffic Signals
- On the MassDOT Traffic Signal Approved Equipment List

An independent lab shall certify that the LED signal module complies with the applicable ITE specification. The independent report should be submitted to MassDOT for review unless the module is already on the approved list.

To prevent the LED module warranty from being voided, the connecting leads on the module shall not be cut. The original LED module leads shall be connected to the signal head terminal block as continuous wire without splices.

The LED signal module will be replaced or repaired by the manufacturer if it exhibits one of the following:

A failure due to workmanship or material defects within the first 60 months of field operation

A greater than 40 percent light output degradation or a fall below the minimum intensity levels (as defined by the latest ITE performance specifications) within the first 36 months of field operation

Posts and Bases

Signal posts and bases shall be aluminum shafts with square aluminum bases.

③ ADDENDUM NO. 3, SEPTEMBER 9, 2014**ITEMS 815.1 thru 815.4** (Continued)Software

All local controller, malfunction management unit, loop detector amplifier, video detection system, and emergency vehicle preemption software shall be supplied with the latest available revision. Any software upgrades released by the manufacturer shall be supplied at no charge to MassDOT for a period of five years after acceptance of the traffic signal installation.

Documentation

The Contractor shall supply an 8.5 inches x 11 inches laminated copy of the traffic signal as-built plan, sequence and timing chart and detector numbers, street names, approach direction, lane assignment, corresponding phone and terminal number to be left in the cabinet documentation envelope mounted on the inside of the cabinet door. The Contractor shall provide as-built drawings in AutoCAD format and digital photos after the final inspection and prior to final acceptance.

METHOD OF MEASUREMENT AND BASIS OF PAYMENT

The LUMP SUM Contract price for ITEMS 815.1, 815.2, 815.3 and 815.4 shall be full compensation for all labor, materials, and equipment necessary or incidental to the installation of a complete, fully operational traffic signal control system including electrical conduit for wire loops other than 3 inches conduit, the controller, cabinet and foundation with concrete pad; mast arm poles, anchor bolts and foundations; signal posts and foundations; signal heads; backplates; all cable and wiring; ground rods, equipment grounding and bonding; service connection software, testing system ground and loops, and all said related items in the manner specified and shown, except as itemized below.

Also included in the LUMP SUM Contract price shall be an appropriate portion of that labor and material, which is not intersection specific but system related.

3-Inch Electrical Conduit shall be measured and paid for separately under Item 804.3.

- ③ 12 x 12 Pull Boxes shall be measured and paid for separately under Item 811.31.

CONSTRUCTION SPECIFICATIONS

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- B. Except where longer periods of warranty are specified for certain items, the Contractor warrants all work done under the Contract to be free from faulty materials and workmanship for a period of one year from date of acceptance thereof.
- C. Upon receiving notification from the Authority, the Contractor shall immediately make the required repairs or replacements to any work found defective. If repairs or replacements are not started within 10 days from the date of notification and prosecuted to completion, the Authority reserves the right to employ others to complete the Work. The Contractor agrees, upon demand, to pay the Authority all amounts which it expends for such repairs or replacements.
- D. All remedied Work shall carry the same warranty as the original work starting with the date of acceptable replacement or repair.

PART 2 - PRODUCTS

PART 3 - EXECUTION

PART 4 - MEASUREMENT AND PAYMENT

Not Used.

END OF SECTION

SECTION 01569

SYSTEM SAFETY CERTIFICATION

PART 1 GENERAL

1.1 DESCRIPTION

- A. This Section specifies requirements to produce a Safety Certification Report which shall certify that at the time of inspection, all Safety Critical Elements of this Contract are safe for passengers, MBTA employees, emergency responders, and the general public. The formal document also ensures that all Safety Critical Elements are in compliance with regulatory codes and agencies.
- B. Final acceptance of the Safety Certification Report shall require written approval of the MBTA Chief of Safety.
- C. The System Safety Certification Program Policy, which applies to operating systems (e.g., fire alarms, operation control centers, vent/fans, signal/power systems, vehicles, and operation plans) and construction projects (i.e., stations, facilities, rails, and bridges). Collection of all certification reports, verification of the safety and acceptance by the MBTA of all Safety Critical Elements, and the Safety Certification Report shall be the responsibility of the Contractor.

1.2 SAFETY CRITICAL ELEMENTS

- A. The safety certification work covers operational safety under system safety, operational safety, and occupational safety. The project elements which are safety critical and a list of specification with inspection, report, and training requirements will be developed by the System Safety Engineer, the Construction Project Manager, and the design consultant.

1.3 PROGRAM TASKS

- A. The MBTA System Safety Engineer shall identify all Safety Critical Elements. The Contractor shall compile and document the safety requirements as described under Part IV, A, Task 1 of the attached System Safety Certification Policy.
- B. The Contractor shall verify equipment and system elements; verify procedural system elements; verify personnel training; verify system integration; and perform safety certification for the Safety Critical Elements of this Contract as described under Part IV B through F of the attached System Safety Certification Policy.

1.4 MEASUREMENT AND PAYMENT

- A. No separate measurement and payment will be made for work required under this Section. All costs in connection therein shall be considered therewith shall be considered incidental to the item or items of work to which they pertain.

MBTA
SYSTEM SAFETY CERTIFICATION PROGRAM

I. INTRODUCTION

The goal of this Safety Certification Program is to certify that all practical steps have been taken to optimize the operational safety of the MBTA during and after construction, before the start of revenue service.

The program will be conducted by the MBTA as a self-certifying agency. The Safety Certification Program is administered by the MBTA Safety Department which reports directly to the General Manager's Office.

The program requires the support of all affected departments. The Safety Department is responsible for coordinating the documentation of all tasks that address safety critical elements. Safety Critical elements are defined as those items assessed as needed to eliminate, minimize, or control hazards, which could result in death, severe injury, or major system or public property damage. Safety certifiable elements exist in system equipment, facilities, procedures, and personnel, both individually, and as an integrated whole. (See Pages 4 & 5 for examples of certifiable elements).

Specific activities of the Certification Process include:

- (a) Identification of safety requirements
- (b) Verification of compliance with safety requirements
- (c) Identification and resolution of non-compliances (open items).

II. PROGRAM OBJECTIVES:

The objective of the Safety Certification Program is to produce a formal document that ensures at the time of operation, a particular system is safe for passengers, employees, emergency responders, and the general public. Safety Certification verifies that the project is in compliance with regulatory codes and agencies. For example, when a train station is modernized, the Safety Certification Program will ensure that the Fire Alarm System meets the applicable state and city codes, and the MBTA will receive an occupancy permit stating the station is acceptable to the fire department. The Safety Certification Program will identify which items require certification and will verify that the contract documents incorporate safety requirements from the design stage. This program will also verify procedures/results and identify open items or work arounds.

The ultimate objective for this program is to provide overall risk reduction by systematically addressing hazards before opening for revenue service. This Safety Certification Program has already proved its importance with the opening of the Blue Line on June 24, 1995, and the New Old Colony Railroad, on September 26, 1997. The Safety Department was able to identify safety critical elements to ensure that they were addressed prior to the start of revenue service.

With this proactive program in place, we can expect positive results: a safer railroad.

III. PROGRAM SCOPE:

The Safety Certification Program covers Operational Safety only, under three different, but overlapping functional areas:

- (a) System Safety - the application of operating, technical, and management techniques and principals to the safety aspects of a system throughout its life to reduce hazards to the lowest practical level through the most effective use of available recourses.
- (b) Fire/Life Safety - elimination, minimization, or control of potential hazards to patrons, employees, emergency response personnel, and the general public caused by fire, smoke, explosion, or resulting in panic; and the protection of MBTA property from fire or explosion.
- (c) Occupational Safety - elimination, minimization, or control of potential hazards to employees and emergency response personnel. (The certification process itself is concerned with the end product, the operational system elements (equipment and facilities, personnel, procedures), and the integration of these elements into one integrated and independent operation).

The following are typical Certifiable Elements:

- (a) Systemwide Elements
 - 1. Safe Braking
 - 2. Automatic Train Control
 - 3. Communications Equipment
 - 4. Passenger Vehicles/Locomotives
 - 5. Train Clearance
 - 6. Running Rail/Field Welds
 - 7. Signals
 - 8. Grade Crossings
 - 9. Bridges/Structures
- (b) Facility
 - 1. Passenger Stations
 - 2. Layover Facilities
 - 3. Site Security
 - 4. Central Control
 - 5. Maintenance Facilities
- (c) Procedural Elements
 - 1. Operations Rules and Procedures
 - 2. Maintenance Rules and Procedures
 - 3. Emergency Response Rules and Procedures
 - 4. Personnel Training and Qualification Procedures
- (d) Personnel Elements
 - 1. Operations Personnel
 - 2. Maintenance Personnel
 - 3. Emergency Response Personnel

(e) Integration Elements

1. Integrated Test Procedures
2. Integrated Test Reports
3. Pre-Revenue Operations Test Procedures, including Emergency Response Scenarios
4. Pre-Revenue Operations Test Reports (e.g., grade crossing tests)

IV. PROGRAM TASKS

The program tasks described in this section comprise the overall certification process. Procedures, methodologies, checklists, work flow charts, schedules and other documentation necessary for the conduct, review and completion of tasks will be prepared under the appropriate task.

A. **TASK 1 - IDENTIFICATION AND DOCUMENTATION OF SAFETY REQUIREMENTS**

This task will involve the identification, compilation and documentation of safety requirements applicable to the equipment/facility and system elements shown under Section III of this plan.

Source documentation for the identification of safety requirements will include:

1. The technical specification for MBTA contract(s).
2. MBTA design and performance criteria.
3. Safety studies and analyses conducted by MBTA or consultants.
4. Pertinent Safety criteria and studies from other rail transit systems.
5. Applicable codes, standards, and regulations.

All safety requirements extracted from the technical specifications for equipment/facility element contracts and procurements will be documented on Safety Certification documents. Safety requirements extracted from source documentation, other than contract or procurement technical specifications, will be identified for resolution as open-items.

Primary emphasis will be given to identifying those safety elements that are "safety critical". Safety critical elements, as defined earlier, are those items assessed as needed to eliminate, minimize, or control hazards, which under consideration of the potentially worst critical mishap could result in death, severe injury, or major system or public property damage. However, safety codes and standards not falling within the above "safety critical" category will be included in the program so that non-critical safety elements can be verified. Safety Critical elements will be shown in "Bold Type" when producing a list of certifiable elements.

B. **TASK 2 - VERIFICATION OF EQUIPMENT/FACILITY AND SYSTEM ELEMENTS**

This task will be applicable to construction, installation, and procurement contracts appropriate to the equipment/facility element being considered. It will involve the completion of the Safety Certification elements listed in Task 1, to verify that contractors have complied with safety requirements. If non-compliance with a safety requirement is identified, it will be logged as an "open item" and tracked for resolution as described under Task 6.

C. TASK 3 -VERIFICATION OF PROCEDURAL SYSTEM ELEMENTS

Safety review and verification of MBTA operational rules and procedures and personnel training documentation will be conducted to ensure that procedural documents display contributions to certifiable levels of safety for the operational system. This task will be verified by the Safety Department.

A Safety Certification Procedures Review Log will be prepared and used to document the results. Where non-compliance with established safety requirements are found, or where new requirements are identified during reviews, they will be logged as an "open item" and tracked for resolution. (See Sample - Table 1).

D. TASK 4 -VERIFICATION OF PERSONNEL TRAINING AND QUALIFICATIONS

Verification of personnel training and qualification for operations, maintenance, and emergency response personnel will be conducted by review of personnel certification documentation provided and approved by the Operations Manager and the Chief Engineer. Verification under this task will be conditional, pending final verification under Task 5 - System Integration.

E. TASK 5 -VERIFICATION OF SYSTEM INTEGRATION

1. This task will consist of safety review and verification of:

- (1) Integrated Test Procedures
- (2) Integrated Test Reports
- (3) Pre-Revenue Operations Test Procedures, including Emergency Response Scenarios
- (4) Pre-Revenue Test Reports

2. Integrated Tests are conducted to verify the physical and/or the functional operations of equipment/facility elements that are integrated with other equipment/facility elements, subsequent to or as part of Acceptance Tests for individual equipment/facility elements. For example, when testing an elevator in a station, you must also test the emergency call system inside the elevator and at the platform at lobby levels. Integrated Test Procedures identified as required to verify the safety of operations, or the integrity of emergency response communications will be reviewed to:

- (1) Verify the incorporation of safety requirements, and
- (2) Verify that the procedural content, including test pre-requisites, is sufficiently consistent with the stated purpose(s) or objective(s) of the test.

Safety requirements will be extracted from pertinent source documentation listed in Task 1. Integrated Test Reports and any separate quality surveillance reports will be reviewed to verify that the safety requirements and parameters established by the approved test procedure have been met, and that any test non-compliances have been resolved.

3. **Pre-Revenue Operations Tests** are conducted subsequent to the completion of integrated tests, to verify the operational readiness of conditionally qualified operational personnel, emergency response personnel, and/or procedures, through simulated revenue service. Normal and abnormal operations are conducted, including emergency response scenarios. Pre-revenue operation test procedures will be reviewed to verify that the stated purpose(s) of the simulated revenue service, and the overall procedural content, are of sufficient scope and depth to display the overall operational safety status. Along with others, Safety personnel will monitor and report on the conduct of pre-revenue operations tests to:
 - a. Assess the effectiveness and the need for additions to, or revisions of, operational rules and procedures, or retraining of personnel.
 - b. Assess the effectiveness of emergency response scenarios and response activities.

Pre-revenue operations test reports, safety assessment reports and any other reports will be reviewed to verify that a certifiable level of operational safety has been demonstrated during the conduct of pre-revenue operations. Where such reports display deficiencies in operational rules or procedures, or in compliance with rules and procedures, or in the effectiveness of the conduct of emergency response procedures, each deficiency will be logged as an "open item" and tracked for resolution as described under Section IV, Task 6.

4. **Pre-revenue operations tests** must be completed at least 2 weeks prior to opening revenue service.

F. TASK 6 - SAFETY CERTIFICATION

This task will be conducted to verify and display, by documentation, that a certifiable level of operational safety has been achieved for the MBTA System, and will include:

1. **Preparation of a chronological summary report** to display and discuss the safety certification activities that have been conducted.
2. **Preparation of a comprehensive list of certification documentation.**
3. **Preparation of an Open Item Status Report**, to display the status of all open items identified during the conduct of the certification program. This report will be based on open items documented on Form SC-2. Form SC-2 will be generated by the System Safety Engineer or designee as needed.

Open items will be resolved by:

1. **Corrective Action**
 - (1) **Contract Change Order or Contract Procurement.**
 - (2) **Resolution**
 - (3) **Temporary Resolution - deferral or corrective action with or without a work around.**
 - (4) **Final Resolution.**

All open items will be entered on a Safety Certification Open Item Status Log which will be used to track, report on and document the resolution of each item until closed out (see sample Table 1).

- 4. A Safety Certification Report will be submitted to the General Manager. This report will be prepared by the Safety Department showing all initial finding(s), conclusion(s), and recommendation(s).**

SECTION 01700

CONTRACT CLOSEOUT

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Work Included: This Section specifies the providing of operations and maintenance manuals, and the providing of As-Built Drawings.**

1.2 OPERATIONS AND MAINTENANCE MANUALS

- A. At least one month prior to turning over the Project to the Authority for occupancy, deliver to the Engineer three complete indexed files containing approved data as follows:**
 - 1. Operating manuals and operating instructions for the various systems.**
 - 2. Catalog data sheets for each item of mechanical equipment actually installed, including performance curves, rating data and parts lists.**
 - 3. Catalog sheets, maintenance manuals, and approved shop drawings of all mechanical equipment controls and fixtures with all details clearly indicated, including size of lamps.**
 - 4. Names, addresses and telephone numbers of repair and service companies for each of the major systems installed.**

AS-BUILT DRAWINGS

- 1. At the start of construction, the General Contractor will obtain an AutoCAD copy of the as-bid design plans from the engineering consultant. These plans will be used as the basis for the project As-Built Plans.**
- 2. At the start of construction, the General Contractor will identify the person responsible for updating the As-Built Plans.**
- 3. During the course of construction, the general contractor's responsible person will maintain a full set of "mark-up" as bid plans on the project site. Any construction work that involves changes from the final design shall be recorded on the "mark-up" plans.**
- 4. At the end of construction, the general contractor shall make the required changes to the design plans as noted on the "mark-up" sheets.**
- 5. The General Contractor shall then complete an internal quality control check of the as-built plans. This review will be completed by the General Contractor's Quality Control Manager. Any deficiencies noted on the plans shall be corrected prior to issuing to the Authority.**

6. The General Contractor shall then submit two (2) ½ size print copies of as-built plans to the MBTA for review. All major plan changes should be clouded for this review. Any deficiencies noted on the plans by the MBTA shall be corrected by the General Contractor.
7. The General Contractor will submit the final as-built plans on computer disk in AutoCAD format to the MBTA Project Manager for recording. All clouds shall be removed in the final version.
8. The General Contractor is responsible for preparing as-built plans. As-built plans submitted by sub-contractors are unacceptable.

1.3 The General Contractor will note the following when preparing MBTA as-built plans:

- A. Each as-built plan shall have the following recorded in the Revision Box:

“As-Built Plan Date”

- B. Each as-built plan shall be stamped “As-Built Plan” in 36 font above the title block of each plan.
- C. Any plan references to “proposed” work shall be changed to “existing” work.
- D. Plan references to specific Request for Information (RFI) or Design Change Requests (DCR) are unacceptable.
- E. If portions of work (walls, utilities, etc.) are relocated, the original plan information shall be removed, and the relocated work recorded on the as-built plan.
- F. On utility work, show ties to all utility structures including but not limited to manholes, catch basins, gate valves, and water shut-offs.
- G. There shall be no “clouded” work, or sections of work marked with an “X” to denote deleted work.
- H. All as-built plan revised work shall be added to the plans through AutoCAD.
- I. If the General Contractor has questions on how to present information on the as-built plans, these issues shall be discussed with the MBTA Project Manager and resolved prior to issuing the as-built plans.

PART 2 - PRODUCTS

PART 3 - EXECUTION

Not Used.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT AND PAYMENT

- A. No separate measurement or payment will be made for work required under this Section. All costs in connection therewith will be considered incidental to the item or items of work to which they pertain.

END OF SECTION

SECTION 02195

GROUND IMPROVEMENT – AGGREGATE PIERS

PART 1 - GENERAL REQUIREMENTS

1.1 Description

Aggregate Pier soil reinforcement is required below various structures for this project as noted on the foundation plan sheets. Work shall consist of designing, furnishing and installing aggregate pier ground improvement to the lines and grades designated on the project foundation plan and as specified herein. The aggregate piers shall be in a columnar-type configuration and shall be used for support of foundation loads.

1.2 Work Included

- A. Provision of all equipment, material, labor, and supervision to design and install aggregate piers. Design shall rely on subsurface information presented in the project geotechnical report. Layout of aggregate piers, spoil removal (as required), footing excavations, and subgrade preparation following aggregate pier installation is not included.
- B. The aggregate pier design and installation shall adhere to all methods and standards described in this Specification.
- C. Drawings and General Provisions of the Contract, including General and Supplemental Conditions, and Division 1 Specifications, apply to the work in this specification.

1.3 Approved Installers

- A. The Aggregate Pier Installer (the Installer) shall be approved by the Owner's Engineer prior to bid opening. Prior to approval, Installers or their Designers are required to submit to the engineer a qualification statement to demonstrate experience on at least 10 projects of a similar scope and nature. Additionally, prior to approval, Installers or their Designers are required to submit to the engineer a preliminary design document and interview with the engineer. Without exception, no alternate installer will be accepted unless approved by the Owner's Engineer at least two (2) weeks prior to bid opening.
- B. Installers of aggregate pier foundation systems shall have a minimum of 5 years of experience with the installation of aggregate pier systems and shall have completed at least 50 projects.

1.4 Reference Standards

A. Design

- 1. "Control of Settlement and Uplift of Structures Using Short Aggregate Piers," by Evert C. Lawton (Assoc. Prof., Dept. of Civil Eng., Univ. of Utah), Nathaniel S. Fox (President, Geopier Foundation Co., Inc.), and Richard L. Handy (Distinguished Prof. Emeritus, Iowa State Univ., Dept. of Civil Eng.), reprinted from *IN-SITU DEEP SOIL IMPROVEMENT, Proceedings of sessions sponsored by the Geotechnical Engineering Division/ASCE in conjunction with the ASCE National Convention held October 9-13, 1994, Atlanta, Georgia.*

2. “Settlement of Structures Supported on Marginal or Inadequate Soils Stiffened with Short Aggregate Piers,” by Evert C. Lawton and Nathaniel S. Fox. *Geotechnical Special Publication No. 40: Vertical and Horizontal Deformations of Foundations and Embankments*, ASCE, 2, 962-974.
3. “Behavior of Geopier[®]-Supported Foundation Systems during Seismic Events,” by Kord Wissmann, Evert C. Lawton, and Tom Farrell. Geopier Foundation Company, Inc. Blacksburg, VA ©1999.
4. “The design of vibro replacement.” H.J. Priebe. *Ground Engineering*, London. Dec 1995.

B. Modulus Testing

1. ASTM D 1143 - Pile Load Test Procedures
2. ASTM D 1194 - Spread Footing Load Test

C. Materials and Inspection

1. ASTM D 1241 - Aggregate Quality
2. ASTM D 422 - Gradation of Soils

- D.** Where specifications and reference documents conflict, the Aggregate Pier Designer shall make the final determination of the applicable document.

1.5 Certifications and Submittals

- A.** Design Calculations - The Installer shall submit detailed design calculations and construction drawings prepared by the Aggregate Pier Designer (the Designer) for review and approval by the Owner or Owner’s Engineer. All plans shall be sealed by a Professional Engineer in the State in which the project is constructed.
- B.** Professional Liability Insurance - The Aggregate Pier Designer shall have Errors and Omissions design insurance for the work. The insurance policy should provide a minimum coverage of \$3 million per occurrence.
- C.** Building Code Acceptance – The Aggregate Pier Installer shall demonstrate that the Aggregate Pier system has been evaluated by the International Code Council (formerly ICBO).
- D.** Modulus Test Reports – A modulus test(s) is performed on a non-production Aggregate Pier element as required by the Aggregate Pier Designer to verify the design assumptions. The Installer shall furnish the General Contractor a description of the installation equipment, installation records, complete test data, analysis of the test data and verification of the design parameter values based on the modulus test results. The report shall be prepared under direction of a Registered Professional Engineer.
- E.** Daily Aggregate Pier Progress Reports – The Installer shall furnish a complete and accurate record of Aggregate Pier installation to the General Contractor. The record shall indicate the pier location, length, volume of aggregate used or number of lifts, densification forces during installation, and final elevations or depths of the base and top of piers. The record shall also indicate the type and size of the installation equipment used, and the type of aggregate used. The Installer shall immediately report any unusual conditions encountered during installation to the General Contractor, to the Designer and to the Testing Agency.

PART 2 - MATERIALS**2.1 Aggregate**

- A. Aggregate used by the Aggregate Pier Installer for pier construction shall be pre-approved by the Designer and shall demonstrate suitable performance during modulus testing. Typical aggregate consists of Type 1 Grade B in accordance with ASTM D-1241-68, No. 57 stone, recycled concrete or other graded aggregate approved by the Designer.
- B. Potable water or other suitable source shall be used to increase aggregate moisture content where required. The General Contractor shall provide such water to the Installer.

PART 3 - DESIGN REQUIREMENTS**3.1 Aggregate Pier Design**

- A. The design of the Aggregate Pier system shall be based on the service load bearing pressure and the allowable total and differential settlement criteria of all footings indicated by the design team for support by the Aggregate Pier system. The Aggregate Pier system shall be designed in accordance with generally-accepted engineering practice and the methods described in Section 1 of these Specifications. The design life of the structure shall be 75 years.
- B. The design shall meet the foundation and slab loading criteria, and settlement performance criteria as shown on the foundation plans and notes.
- C. The Rammed Aggregate Pier elements shall be designed using a Rammed Aggregate Pier stiffness modulus to be verified by the results of the modulus test described in Section 5.02 of these specifications.

3.2 Design Submittal

The Installer shall submit detailed design calculations, construction drawings, and shop drawings, (the Design Submittal), for approval at least 6 week(s) prior to the beginning of construction. A detailed explanation of the design parameters for settlement calculations shall be included in the Design Submittal. Additionally, the quality control test program for Aggregate Pier system, meeting these design requirements, shall be submitted. All computer-generated calculations and drawings shall be prepared and sealed by a Professional Engineer, licensed in the State or Province where the piers are to be built. Submittals will be submitted electronically only unless otherwise required by specific submittal instructions.

- A. The following shall be included in the design calculation submittal:
 - 1. A written summary report that describes the overall ground improvement design.
 - 2. Applicable code requirements and design references.
 - 3. Ground improvement critical design cross-section(s) geometry including soil/rock strata and location, magnitude and direction external surcharge loads and piezometric levels with critical slip surface shown along with minimum calculated global stability factor of safety.

- 4. Design criteria including, soil/rock shear strengths including friction angle and cohesion, unit weights, aggregate pier hole diameter, aggregate pier spacing, aggregate pier unit weight and friction angle, composite shear strength parameters and any other design assumptions.**
 - 5. Design calculation sheets with project number, wall location, designation, date of preparation, initials of designer and checker, and page number at the top of each page. An index page with the design calculations shall be provided.**
 - 6. Design notes including an explanation of any symbols and computer programs used in the design.**
 - 7. Detailed subgrade preparation notes and requirements.**
- B. Working Drawings. Utility locations, right of way and other applicable information is available on the plans. Working drawings shall include, but not be limited to the following items:**
- 1. A plan view of the ground improvement for the identifying:**
 - 1.1 Right of way, permanent or temporary construction easement limits, location of all known active or abandoned existing utilities, adjacent structures, or other potential interferences. Any drainage structure or drainage pipe centerline behind, passing through, or passing under the structure.**
 - 1.2 Limits of the ground improvement and layout of the individual aggregate piers.**
 - 2. Subsurface exploration locations shown on a plan view of the proposed structure alignment with appropriate reference base lines to fix the locations of the explorations relative to the structure.**
 - 3. Elevation view showing aggregate pier locations, elevations and depth of improvement; location of drainage elements and expansion/contraction joints when applicable.**
 - 3.1 Existing and finish grade profiles both behind and in front of the structure.**

PART 4 - EXECUTION

4.1 Approved Installation Procedures

The following sections provide general criteria for the construction of the Aggregate Piers. Unless otherwise approved by the Designer, the installation method used for Aggregate Pier construction shall be that as used in the construction of the successful modulus test.

- A. Aggregate Piers Installed using augered Rammed Aggregate Pier systems**
- 1. Augered Rammed Aggregate Pier systems shall be pre-augered using mechanical drilling or excavation equipment.**
 - 2. If cave-ins occur during excavation such that the sidewalls of the hole are deemed to be unstable, steel casing shall be used to stabilize the cavity may be used.**

3. Aggregate shall be placed in the augered cavity in compacted lift thicknesses no greater than 24 inches as determined by the Aggregate Pier Designer.
4. Should cave-ins occur on top of a lift of aggregate such that the volume of the caved soil is greater than 10 percent of the volume of the aggregate in the lift, then the aggregate shall be considered contaminated and shall be removed and replaced with uncontaminated aggregate.
5. A specially-designed beveled tamper and high-energy impact densification apparatus shall be employed to densify lifts of aggregate during installation. The tamper diameter shall be at least 80% of the pre-augered hole diameter. The apparatus shall apply direct downward impact energy to each lift of aggregate.
6. The Installer shall provide a full-time Quality Control technician on-site during the installation process.

B. Aggregate Piers Installed using Vibroflot Stone Columns

1. If vibroflot stone column construction is used to construct the Aggregate Piers, the Installer shall use an electric down-hole vibroflot (probe) capable of providing at least 200 HP of rated energy and a centrifugal force of 20 tons. The vibroflot diameter must be at least 60% of the Aggregate Pier design diameter. An appropriate metering device should be provided at such a location that inspection of amperage build-up may be verified during the operation of the equipment. Metering device may be an ammeter directly indicating the performance of the vibroflot tip of the eccentric. Complete equipment specifications should be submitted to the Engineer prior to commencement of the fieldwork.
2. The probe and follower tubes shall be of sufficient length to reach the elevations shown on the installer's approved construction drawings. The probe, used in combination with the available pressure to the tip jet, shall be capable of penetration to the required tip elevation. Pre-augering shall be used to aid penetration.
3. The probe shall penetrate into the foundation soil layer to the minimum depths required in the installer's construction plans. After penetration to the required depth, the probe shall not be withdrawn more than 2 feet at any time unless the stone stops flowing to the bottom of the probe.
4. Redriving the probe into the treated depth shall be attempted at approximately 12 to 18-inch intervals to observe resistance to penetration and amperage build-up. During redriving, the probe tip shall penetrate to within 1 foot of the previous redriving depth.
5. Amperage build-up and backfill quantities will be contingent upon the type of probe used and procedures. Prior to commencement of work, the contractor shall discuss the equipment capabilities with the Engineer to determine if trial probes will be necessary.
6. The Installer shall provide a full-time quality control technician on-site during the installation process.

4.2 Plan Location and Elevation of Aggregate Piers

The as-built center of each pier shall be within 6 inches of the locations indicated on the plans. Piers installed outside of the above tolerances and deemed not acceptable shall be rebuilt at no additional expense to the Owner.

4.3 Rejected Aggregate Piers

Aggregate Pier elements installed beyond the maximum allowable tolerances shall be abandoned and replaced with new piers, unless the Designer approves the condition or provides other remedial measures. All material and labor required to replace rejected piers shall be provided at no additional cost to the Owner, unless the cause of rejection is due to an obstruction or mislocation.

PART 5 - QUALITY CONTROL**5.1 Control Technician**

The Installer shall have a full-time, on-site Control Technician to verify and report all installation procedures. The Installer shall immediately report any unusual conditions encountered during installation to the Aggregate Pier Designer, the General Contractor, and to the Testing Agency. The quality control procedures shall include the preparation of Aggregate Pier Progress Reports completed during each day of installation containing the following information:

1. Footing and Aggregate Pier location.
2. Pre-auger diameter and soil conditions encountered during drilling (if required).
3. Aggregate Pier length.
4. Planned and actual Aggregate Pier elevations at the top and bottom of the Aggregate Pier.
5. Average lift thickness of each Aggregate Pier.
6. Volume of aggregate used in each Aggregate Pier.
7. Documentation of any unusual conditions encountered.
8. Type and size of densification equipment used.

5.2 Aggregate Pier Modulus Test

A minimum of one (1) Modulus Test is required for this project. When authorized, an Aggregate Pier Modulus Test(s) shall be performed at locations agreed upon by the Aggregate Pier Designer and the Testing Agency to verify or modify Aggregate Pier designs. Modulus Test Procedures shall utilize appropriate portions of ASTM D 1143 and ASTM D 1194, as outlined in the Aggregate Pier design submittal. Aggregate Piers shall be tested to 150 percent of the maximum design stress as shown in the aggregate pier design submittal. The modulus tests shall be of the type and installed in a manner specified herein.

- A. A telltale shall be installed at the bottom of the test pier so that bottom-of-pier deflections may be determined. Acceptable performance is indicated when the bottom of the pier deflection is no more than 30% of the top of pier deflection at the design stress level.
- B. ASTM D-1143 general test procedures shall be used as a guide to establishing load increments, load increment duration, and load decrements. As a minimum, the following loading increments, decrements and duration shall be used.

<u>Increment</u>	<u>Approximate Load</u> <u>(percent design)</u>	<u>Minimum</u> <u>Duration (min)</u>	<u>Maximum</u> <u>Duration (min)</u>
Seat	< 9	0	N/A
1	17	15	60
2	33	15	60
3	50	15	60
4	67	15	60
5	83	15	60
6	100	15	60
7	117	60	120
8	133	15	60
9	150	15	60
10	100	N/A	N/A
11	66	N/A	N/A
12	33	N/A	N/A
13	0	N/A	N/A

- C. With the exception of the load increment representing approximately 117% of the design maximum top of Aggregate Pier stress, all load increments shall be held for a minimum of 15 minutes. Loads are then maintained until the rate of deflection reduces to 0.01 inch per hour or for the maximum of 1 hour, whichever is occurs first.
- D. The load increment that represents approximately 117% of the design maximum stress on the Aggregate Pier shall be held for a minimum of 15 minutes. Loads are then maintained until the rate of deflection reduces to 0.01 inch per hour or for the maximum of 4 hours, whichever is occurs first.
- E. A seating load equal to 5 percent of the total load shall be applied to the loaded steel plate prior to application of load increments and prior to measurement of deflections to compensate for surficial disturbance.

5.3 Bottom Stabilization Testing (BSTs) / Crowd Stabilization Testing (CSTs)

Bottom stabilization testing (BSTs) or Crowd stabilization testing (CSTs) shall be performed by the Control Technician during the installation of the modulus test pier. The tests are performed by applying downward vertical energy to the tamper, mandrel or probe following lift construction and monitoring the amount of additional deflection from the applied energy. Additional testing as required by the Aggregate Pier Designer (typically 10% of the production Aggregate Piers) shall be performed on selected production Aggregate Pier elements to compare results with the modulus test pier.

PART 6 - QUALITY ASSURANCE

6.1 Independent Engineering Testing Agency (Owner's Quality Assurance)

The Aggregate Pier Installer shall provide full-time Quality Control monitoring of Aggregate Pier construction activities. The Owner or General Contractor is responsible for retaining an independent engineering testing firm to provide Quality Assurance services.

6.2 Responsibilities of Independent Engineering Testing Agency

- A. The Testing Agency shall monitor the modulus test pier installation and testing. The Installer shall provide and install all dial indicators and other measuring devices.
- B. The Testing Agency shall monitor the installation of Aggregate Piers to verify that the production installation practices are similar to those used during the installation of the modulus test elements.
- C. The Testing Agency shall report any discrepancies to the Installer and General Contractor immediately.
- D. The Testing Agency shall observe the excavation, compaction and placement of the foundations as described in Section 7.05. Dynamic Cone Penetration testing may be performed to evaluate the footing bottom condition as determined by the Testing Agency.
- E. The Testing Agency shall observe subsurface soils are consistent with the design assumptions.

PART 7 - RESPONSIBILITIES OF THE GENERAL CONTRACTOR

7.1 Site Preparation and Protection

- A. The General Contractor shall locate and protect underground and aboveground utilities and other structures from damage during installation of the Aggregate Piers.
- B. Site grades for aggregate pier installation shall be within 1 foot of the top of footing elevation or finished grade elevation to minimize aggregate pier installation depths. Ground elevations and bottom of footing elevations shall be provided to the Rammed Aggregate Pier Installer in sufficient detail to estimate installation depth elevations to within 3 inches.
- C. The General Contractor will provide site access to the Installer, after earthwork in the area has been completed. A working surface shall be established and maintained by the General Contractor to provide wet weather protection of the subgrade and to provide access for efficient operation of the Aggregate Pier installation.
- D. Prior to, during and following Aggregate Pier installation, the General Contractor shall provide positive drainage to protect the site from wet weather and surface ponding of water.
- E. If spoils are generated by aggregate pier installation, spoil removal from the aggregate pier work area in a timely manner to prevent interruption of aggregate pier installation is required.

7.2 Aggregate Pier Layout

The location of aggregate pier-supported foundations for this project, including layout of individual aggregate pier elements, shall be marked in the field using survey stakes or similar means at locations shown on the drawings.

7.3 Contractor's / Owner's Independent Testing Agency (Owner's Quality Assurance)

General Contractor is responsible for acquiring an Independent Testing Agency (Quality Assurance) as required. Testing Agency roles are as described in Part 6 of this specification. The Aggregate Pier Installer will provide Quality Control services as described in Part 5 of this specification.

7.4 Excavations for Obstructions

- A. Should any obstruction be encountered during Aggregate Pier installation, the General Contractor shall be responsible for promptly removing such obstruction, or the pier shall be relocated or abandoned. Obstructions include, but are not limited to, boulders, timbers, concrete, bricks, utility lines, etc., which shall prevent placing the piers to the required depth, or shall cause the pier to drift from the required location.
- B. Dense natural rock or weathered rock layers shall not be deemed obstructions, and piers may be terminated short of design lengths on such materials.

7.5 Utility Excavations

The General Contractor shall coordinate all excavations made subsequent to Aggregate Pier installations so that excavations do not encroach on the piers as shown in the Aggregate Pier construction drawings. Protection of completed Aggregate Piers is the responsibility of the General Contractor. In the event that utility excavations are required in close proximity to the installed Aggregate Piers, the General Contractor shall contact the Aggregate Pier Designer immediately to develop construction solutions to minimize impacts on the installed Aggregate Pier elements.

7.6 Footing Bottoms

- A. Excavation and surface compaction of all improved subgrades shall be the responsibility of the General Contractor.
- B. Foundation excavations to expose the tops of Aggregate Piers shall be made in a workman-like manner, and shall be protected until concrete placement, with procedures and equipment best suited to (1) avoid exposure to water, (2) prevent softening of the matrix soil between and around the Aggregate Piers before pouring structural concrete, and (3) achieve direct and firm contact between the dense, undisturbed Aggregate Piers and the concrete footing.
- C. All excavations for footing bottoms supported by Aggregate Pier foundations shall be prepared in the following manner by the General Contractor. Recommended procedures for achieving these goals are to:
 - 1. Limit over-excavation below the bottom of the footing to 3-inches (including disturbance from the teeth of the excavation equipment).
 - 2. Compaction of surface soil and top of Aggregate Piers shall be prepared using a motorized impact compactor ("Wacker Packer," "Jumping Jack," or similar). Sled-type tamping devices shall only be used in granular soils and when approved by the designer. Loose or soft surficial soil over the entire footing bottom shall be recompacted or removed, respectively. The surface of the aggregate pier shall be recompacted prior to completing footing bottom preparation.

3. Place footing concrete immediately after footing excavation is made and approved, preferably the same day as the excavation. Footing concrete must be placed on the same day if the footing is bearing on moisture-sensitive soils. If same day placement of footing concrete is not possible, open excavations shall be protected from surface water accumulation. A lean concrete mud-mat may be used to accomplish this. Other methods must be pre-approved by the Designer.
- D. Subgrade Preparation:** Following aggregate pier installation, the General Contractor will prepare the subgrade prior to the placement of new engineered fill for earth embankments or MSE retaining walls. The subgrade preparation and fill placement shall be performed in accordance with project specifications.
1. Compaction of surface soil and top of Aggregate Piers shall be prepared using a sled-type tamping device. Motorized impact compactors (“Wacker Packer,” “Jumping Jack,” or similar) shall only be used in cohesive soils and when approved by the designer. Loose or soft surficial soil over the entire footing bottom shall be recompacted or removed, respectively. The surface of the aggregate pier shall be recompacted prior to completing subgrade preparation.
- E.** The following criteria shall apply, and a written inspection report sealed by the project Testing Agency shall be furnished to the Installer to confirm:
1. That water has not been allowed to pond over the aggregate pier subgrade at any time.
 2. That all Aggregate Piers designed for each structure have been exposed in the footing excavation or prior to fill placement.
 3. That immediately before footing construction or fill placement, the tops of Aggregate Piers have been inspected and recompacted as necessary with mechanical compaction equipment.
 4. That no excavations or drilled shafts (elevator, etc) have been made after installation of Aggregate Pier elements within the excavation limits described in the Aggregate Pier construction drawings, without the written approval of the Installer or Designer.
- F.** Failure to provide the above inspection and certification by the Testing Agency, which is beyond the responsibility of the Aggregate Pier Installer, may void any written or implied warranty on the performance of the Aggregate Pier system.

PART 8 – PAYMENT

7.1 GENERAL

- A. Separate measurement and payment will not be made for the work of this section, but all costs in connection therewith will be included in the Contract Lump Sum Price for Item No. 745.01 – Bus Rapid Transit Stations.**

END OF SECTION

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SECTION 02470

SITE IMPROVEMENTS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. This Section specifies furnishing and installation of miscellaneous site improvements including bicycle shelters, benches and trash receptacles.
- B. Concrete, concrete reinforcement, miscellaneous metals and incidentals thereto shall conform to the applicable requirements of the Contract Specification Sections 03300, 05041 and 05500.

1.02 SUBMITTALS

- A. Shop Drawings
 - 1. Submit shop drawings and samples for the bicycle racks for review and approval prior to fabrication.
 - 2. Submit shop drawings including catalog cuts and literature for benches.
 - 3. Submit detailed shop drawings of product including overall dimensions and options including catalog cuts, literature and full range of material samples for color selection for trash receptacles.

PART 2 - PRODUCTS

2.01 BICYCLE SHELTERS

- A. The bicycle shelter frames shall be heavy duty high quality ASTM36 Schedule 40 steel framing, with dimensions as shown on the Contract Drawings. Finishes galvanized steel with Color Galvanized finish. The bicycle rack shall provide lock supports per ASTM A-36. The entire rack shall be galvanized with black powder coated finish, after fabrication.
- B. The bicycle shelter shall have a Translucent polycarbonate PCSS-clear opal roof structures to the dimensions shown on the Drawings
- C. Concrete foundations shall be 5000 **psi, ¾ in., 705 Cement Concrete.**
- D. All hardware shall be fabricated from steel and galvanized after fabrication.

2.02 BENCHES

- A. The benches shall consist of materials and dimensions as shown on the Contract Drawings. Basis of Design is Tangent Rail Seating by Fors+Surfaces. Custom powder-coated color for each of the 4 Stations as selected by the Engineer.

2.03 TRASH RECEPTACLES

SECTION 03300

CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Work Included: This Section specifies the following items:
1. Cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures and finishes for the following applications:
 - a. Footings.
 - b. Foundation walls.
 - c. Concrete Canopy Structures at Bus Rapid Transit Stations
 - d. Concrete Platforms for Bus Rapid Transit Stations
 - e. Concrete long span arches at Box District Station
- B. Items To Be Installed Only: Install the following items as furnished by the designated Sections:
1. Section 05100 - STRUCTURAL STEEL:
 - a. Lintels, sleeves, anchors, inserts, embedded wall plates, loose leveling plates and similar items.
 2. Section 05500 - MISCELLANEOUS METALS:
 - a. Lintels, sleeves, anchors, inserts, plates and similar items for miscellaneous and ornamental metal.
 3. Division 16 - ELECTRICAL:
 - a. Lintels, sleeves, anchors, inserts, plates, floor boxes and similar items for electrical systems.
- C. Related Work: The following items are not included in this Section and will be performed under the designated Sections:
1. **Section 02470 – SITE IMPROVEMENTS; bicycle shelter foundations**
 2. Section 08801 – GLASS AND GLAZING; canopy roof structure.
 3. **Section 09360 – MODULAR TACTILE SURFACES; setting tactile pavers**
 4. Section 09861 – ANTI-GRAFFITI COATINGS: finish treatment
 5. **Section 10400 – FIXED SIGNAGE; sign foundations**
 6. **Section 10428 – MBTA LOLLIPOP SIGN; sign foundations**
 7. **Division 16 – ELECTRICAL**

1.2 DEFINITIONS

- A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash and other pozzolans, ground granulated blast-furnace slag, and silica fume; subject to compliance with requirements.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Design Mixtures: For each concrete mixture, submit proposed mix proportions and test results confirming mix meets requirements stated below. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
 - 1. Indicate amounts of mixing water to be withheld for later addition at Project site.
- C. Steel Reinforcement Shop Drawings: Placing drawings that detail fabrication, bending, and placement. Include bar sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement.
 - 1. Indicate coordination requirements for reinforcement locations with requirements of structural steel, steel joints and steel deck.
- D. Formwork Shop Drawings: Prepared by or under the supervision of a qualified professional engineer licensed in the Commonwealth of Massachusetts detailing fabrication, assembly, and support of formwork.
 - 1. Shoring and Reshoring: Indicate proposed schedule and sequence of stripping formwork, shoring removal, and installing and removing reshoring.
 - 2. Blockouts for Architectural Joint Systems: Indicate blockouts and coordination with architectural joint systems.
- E. Material Test Reports: For the following, from a qualified testing agency, indicating compliance with requirements:
 - 1. Aggregates.
- F. Material Certificates: For each of the following, signed by manufacturers:
 - 1. Cementitious materials.
 - 2. Admixtures.
 - 3. Form materials and form-release agents.
 - 4. Steel reinforcement and accessories.
 - 5. Fiber reinforcement.
 - 6. Waterstops.
 - 7. Curing compounds.
 - 8. Floor and slab treatments.
 - 9. Bonding agents.

10. Adhesives.
 11. Vapor retarders.
 12. Semirigid joint filler.
 13. Joint-filler strips.
 14. Repair materials.
- G. Floor surface flatness and levelness measurements to determine compliance with specified tolerances and requirements for applied finishes and materials, except as noted for slope to drains.
- H. Field quality-control test and inspection reports.
- I. Minutes of preinstallation conference.

1.4 QUALITY CONTROL /QUALITY ASSURANCE

- A. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment. Manufacturer shall be responsible for sampling and testing of concrete ingredients and establishing concrete mix proportions.
- B. Testing and Inspection Services by the Authority: Concrete plant inspection; and field control will be by the Authority at the expense of the Authority.
1. The Contractor agrees to accept as indicative, the results of tests, including test results involving mix designs and field quality control of concrete mixtures. If, as a result of these tests, it is determined that the specified concrete properties are not being obtained, the Engineer may order such changes in proportions or materials, or both, as may be necessary to secure the specified properties, at no additional expense to the Authority.
 2. The use of testing and inspection services shall in no way relieve the Contractor of his responsibility to furnish materials and construction in compliance with the Contract Documents.
 3. Failure to detect any defective work or material shall not in any way prevent later rejection when such defect is discovered nor shall it obligate the Engineer for final acceptance.
 4. Additional testing and inspection services requested by the Contractor because of changes in materials, sources, or proportions, or occasioned by failure of tests and inspection to meet specification requirements, shall be paid for by the Contractor. The costs for such additional testing and inspection services will be established by the Engineer.
 - a. Provide at no additional expense to the Authority all materials, labor, and services for sampling and testing required by the Engineer, including but not limited to:
 - b. Transportation of sample materials from source to the Authority's Materials Testing Laboratory.
 - c. Preparation, handling, storage and transportation of concrete test specimens as directed by the Engineer.
 - d. Suitable containers for the storage, curing and transportation of concrete test specimens in accordance with ASTM C 31.

- e. Suitable storage for a supply of test cylinder molds, test equipment and other items required for sampling and testing.
- C. When additional sets of test cylinders beyond the mandatory seven and twenty-eight day tests are required by the Contractor to verify early form removal or other reasons for his benefit, the Authority shall be reimbursed for the cost of fabricating and testing these additional test cylinders. The Contractor has the option of obtaining additional test services from an independent testing laboratory agency approved by the Engineer. Copies of test data from these additional tests shall be submitted to the Engineer for review and approval.
- D. The minimum number of test cylinders to be made for each class of concrete and for each placement will be four for each 100 cubic yards or less and minimum of four extra cylinders for each additional 50 cubic yards or fraction thereof. When additional sets of test cylinders are required beyond the normal seven and twenty-eight day tests, each set will consist of a minimum of two test cylinders.
- E. Independent Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated, as documented according to ASTM E 548.
 - 1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-01 or an equivalent certification program.
 - 2. Personnel performing laboratory tests shall be ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician - Grade I. Testing Agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician - Grade II.
- F. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from one source, and obtain admixtures through one source from a single manufacturer.
- G. Welding: Qualify procedures and personnel according to AWS D1.4, "Structural Welding Code--Reinforcing Steel".
- H. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:
 - 1. ACI 301, "Specification for Structural Concrete".
 - 2. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials".
- I. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.
- J. Preinstallation Conference: Conduct conference at Project site to address the following:
 - 1. Before submitting design mixtures, review concrete design mixture and examine procedures for ensuring quality of concrete materials. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:
 - a. Contractor's superintendent.
 - b. Independent testing agency responsible for concrete design mixtures.

- c. Ready-mix concrete manufacturer.
 - d. Concrete subcontractor.
2. Review special inspection and testing and inspecting agency procedures for field quality control, concrete finishes and finishing, cold- and hot-weather concreting procedures, curing procedures, construction contraction and isolation joints, and joint-filler strips, semirigid joint fillers, forms and form removal limitations, shoring and reshoring procedures, vapor-retarder installation, anchor rod and anchorage device installation tolerances, steel reinforcement installation, floor and slab flatness and levelness measurement, concrete repair procedures, and concrete protection.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage. Avoid damaging coatings on steel reinforcement.
- B. Waterstops: Store waterstops under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.

PART 2 - PRODUCTS

2.1 CONCRETE MATERIALS

- A. Cement: Shall be American-made Portland Cement, free from water soluble salts or alkalis which will cause efflorescence on exposed surfaces. Portland Cement shall be Type II, ASTM C 150. Use only one brand of cement for each type of cement throughout project. Contractor shall be responsible for whatever steps are necessary to insure that no visual variations in color will result in exposed concrete and shall place on order and secure in advance a sufficient quantity of this (these) cement(s) to complete concrete work specified herein.
 - 1. Fly Ash: ASTM C 618, Type F 15-35%
 - 2. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120, 25-50%
- B. Normal Weight Fine Aggregate: Shall be washed, inert, natural sand conforming to ASTM C 33 and following additional requirements:

<u>Sieve</u>	<u>Percent Passing</u>
#4	95-100 (typical)
#16	50-85
#50	5-30
#100	0-10
Fineness Modulus	2.80 (Plus/Minus 0.20)
Organic	Plate 2 maximum
Silt	2.0 percent maximum
Mortar Strength	100 percent minimum compression ratio
Soundness	15 percent maximum loss, magnesium sulfate, five cycles

- C. Normal Weight Coarse Aggregate: Shall be well graded crushed stone or washed gravel conforming to ASTM C 33 and the following additional requirements:

Designated Size (inches)	3	2	1-1/2	1	3/4	1/2	3/8
F.M. (+/-0.20)	7.95	7.45	7.20	6.95	6.70	6.10	4.50
Organic	Plate 1 maximum						
Silt	1.0 percent maximum						
Soundness	5 percent maximum loss, magnesium sulfate, five cycles						

- D. Maximum designated sizes for normal weight coarse aggregate to be used in concrete sections shall be as noted below, except that sizes shall also be chosen in conjunction with required clearances.

1. One and one-half inches for sections over ten inches in thickness.
2. One inch for sections more than eight and up to ten inches in thickness.
3. Three-quarter inch for sections more than three and up to eight inches in thickness.

- E. Concrete Fill for Steel Stair and Landing Pans: Composed of 1:2:2 mix with three-eighths inch maximum size normal weight aggregate and shall be placed with a 0 inches to 1 inch slump.

- F. Water: From approved source, potable, clean and free from oils, acids, alkali, organic matter and other deleterious material and complying with the requirements of ASTM C 94.

- G. Admixtures:

1. Water-reducing agent:
 - a. "WRDA" - W.R. Grace & Co.
 - b. "PDA25" - Protex Industries, Inc.
 - c. "Pozzolith 344H" - Master Builder's Co.
 - d. Or approved equivalent
 - e. Note: Water-reducing agent shall be by same manufacturer as air-entraining agent.
2. Air-entraining agent:
 - a. "DAREX AEA" - W.R. Grace & Co.
 - b. "PROTEX AEA" - Protex Industries
 - c. "MB-VR" or "MB-AE" - Master Builder's Co.
 - d. Or approved equivalent
3. Superplasticizer: High-range water-reducer conforming to ASTM C 494, Type F or Type G.
4. Admixtures retarding setting of cement in concrete shall not be used without written approval of Engineer.
5. Admixtures causing accelerated setting of cement in concrete shall not be used without written approval of Engineer.

2.2 CONCRETE MIXTURES

- A. The Contractor shall recommend, on the basis of trial mixes and strength curves specified below, design mixes for each type and strength of concrete. The Testing Agency will verify that the proposed mix designs conform to all specification requirements.
- B. Sufficient materials for concrete mix design shall be furnished by Contractor not less than five weeks before use. Duplicate small samples plainly and neatly labeled with source, where proposed to be used, date, and name of collector shall be provided and presented to Testing Agency for permanent reference.
- C. Mixes shall be designed in accordance with "Method 1" of ACI 301, and the requirements of this Section. All concrete is normal weight unless specifically designated otherwise; air-dry weight not to exceed 150 lbs. per cubic foot.
- D. All structural concrete shall have a minimum 28 day compressive strength of 4,000 psi.
- E. Exterior concrete shall contain air-entraining admixture when tested to ASTM C 231 at the point of discharge from the truck mixer:

<u>Aggregate Size</u>	<u>Air Content, %</u>
1-1/2 in.	4.5 - 7.5
3/4 in.	5.0 - 8.0
3/8 in.	6.0 - 9.0

- F. Concrete shall have the following slump when tested to ASTM C 143 at the point of discharge from the truck mixer:

<u>Condition</u>	<u>Slump, inches</u>
With Water-Reducing Agent	4-1/2 - 7
With High-Range W/R Agent	7-9
Without Water-Reducing Agent	2 - 5

- G. Concrete slabs, including slabs on grade, shall have a mid-range water reducer and have a maximum slump of 6 inches.
- H. The approved superplasticizer shall be used in all concrete walls, including slabs on grade.
- I. Design mix of concrete to be used in work shall correspond to following test strengths (TABLE A) obtained in laboratory trial mixtures.

TABLE A

Minimum Strength of Lab Trial Mixes (psi)

Design Strength	Trial Mix Strength	
	7-days	28-days
4000	3400	5200
5000	4200	6200

- J. Any deviation from approved mix design, which Contractor deems desirable under certain project conditions, will not be allowed without written approval of Engineer. Cost of any additional testing by Testing Agency associated therewith shall be paid for by Contractor.

2.3 FORM MATERIALS

- A. Construct formwork to shapes, lines, and dimensions required, plumb and straight, secured and braced sufficiently rigid to prevent deformation under load, and sufficiently tight to prevent leakage, all in conformance with ACI Standard 347, "Recommended Practice for Concrete Formwork".
- B. Formwork for exposed concrete shall be medium-density plastic overlaid plywood, 5/8" minimum thickness; for concealed concrete shall be "Plyform" plywood, 5/8" minimum thickness.
- C. Chamfer Strips: Half-inch, 45 degree poplar wood strips, nailed six inches on center, and installed in inside corners of all forms, unless otherwise directed by Engineer.
- D. Form Ties and Spreaders: Richmond Tyscrus by Richmond Screw Anchor Co.; Superior-ties by Superior Concrete Accessories, Ind.; or Sure-Grip Ties by Dayton Sure-Grip and Shore Co. Wire ties shall not be used. Ties for foundation walls shall be snap-ties or type specified above with removal cones and shall incorporate water seal washer. Ties shall be arranged in a symmetrical manner.
- E. Form Release Agent: Non-staining and non-emulsifiable type, or equal approved by Engineer. Form release agent shall be biodegradable and shall not impart any stain to concrete nor interfere with adherence of any material to be applied to concrete surfaces.

2.4 REINFORCEMENT AND ACCESSORIES

- A. Reinforcing Steel Bars: Shall be newly rolled billet steel conforming to ASTM A 615 Grade 60. Bars shall be bent cold.
- B. Welded Wire Fabric: Shall conform to ASTM A 185.
- C. All hot-dip galvanized steel, when specified on drawings, shall be inspected for compliance with ASTM A 123 and shall be marked with a stamp that indicates the number of ounces of zinc per square foot of steel. After galvanizing, the bars shall be dipped in a 0.2 percent chromic acid solution. A notarized Certificate of Compliance with all of the above shall be required from the galvanizer.
- D. Reinforcement Accessories: Shall conform to Product Standard PS7-766, National Bureau of Standards, Department of Commerce, Class C, as produced by Superior Concrete Accessories, Inc.; Dayton Sure-Grip Co.; or R.K.L. Building Specialties Co., Inc. Reinforcement accessories shall include spacers, chairs, ties, slab bolsters, clips, chair bars, and other devices for properly assembling, placing, spacing, supporting, and fastening reinforcement. Tie wire shall be galvanized or stainless wire of sufficient strength for intended purpose, but not less than No. 18 gage. Metal supports shall be of such type as not to penetrate surface of formwork and show through surface of concrete. Accessories touching interior formed surfaces exposed to view shall have not less than 1/8 inch of plastic between metal and concrete surface. Plastic tips shall

extend not less than 1/2 inch up on metal legs. Individual and continuous slab bolsters and chairs shall be of type to suit various conditions encountered and must be capable of supporting 300 pound load without damage or permanent distortion.

2.5 MISCELLANEOUS MATERIALS

- A. Grout: Ready-to-use aggregate product requiring only addition of water at job site such as "Embeco Pre-mixed Grout" by Master Builder's; "Vibro-Foil Ready-Mixed" by W.R. Grace & Co.; or "Ferrolith G" by Sonneborn Building Products, Inc. Grout shall be easily workable and shall have no drying shrinkage at any age. Compressive strength of grout (2" x 2" cubes) shall not be less than 5000 psi at 7 days, and 7500 psi at 28 days.
- B. Waterstops: Extruded virgin PVC containing no scrap or reclaimed material or pigment. Provide cross section as indicated, uniform along the length of the waterstop and symmetrical transversely so that the thickness at any given distance from either edge of the waterstop will be uniform. The finished waterstop shall meet the requirements specified below for the average of five samples tested in each case. Report standard deviations of values in addition to averages. Condition and test samples in atmosphere of 73 (plus or minus 3) degrees F and 50 (plus or minus 10) percent relative humidity, except where other test conditions are specified.
 - 1. Tensile strength, per ASTM D 638. Die IV-: 2000 psi. minimum.
 - 2. Ultimate elongation, per ASTM D 638. Die IV: 350 percent, minimum.
 - 3. Tear resistance, per ASTM D 624. Die B: 350 pounds per inch of thickness, minimum
 - 4. Stiffness in flexure, samples reduced to 1/8-inch thickness, per ASTM D 747. 1/4 inch span: 600 psi. minimum.
 - 5. Low temperature brittleness samples reduced to 1/8-inch thickness, per ASTM D 746: no cracking, chipping, or sign of failure at minus 35 degrees F.
 - 6. Accelerated Extraction, samples reduced to 1/8-inch thickness, per Corps of Engineers CRDC-572: tensile strength, per ASTM D 412. Die C 1750 psi. minimum; ultimate elongation, per ASTM D 412. Die C: 300 percent, minimum.
 - 7. Effect of Alkali, samples reduced to 1/8-inch thickness, per Corps of Engineers CRDC-572: Change in weight. 7 days: minus 0.10 to plus 0.25 percent; Change in weight. 30 days minus 0.10 to plus 0.25 percent; Change in hardness. 7 days. per ASTM D 2240. Shore A-2: plus or minus 5 points; Change in thickness. 30 days: plus or minus 1.0 percent.
 - 8. Tensile strength of samples taken across site-made and factory-made splices, per ASTM D 638 Die I \1000 psi. minimum
- C. Vapor Barrier: 6 mil polyethylene, unless specifically specified elsewhere.
- D. Membrane Curing Compound: ASTM C 309, Type 1. Product used shall be shown to be compatible with the later application of coatings. Curing compound shall not be used on any floor slab scheduled to receive an adhered floor finish.
- E. Membrane Curing Compound for Architectural Concrete: Liquid membrane curing compound complying with AASHTO M148, Type 1D, except Type 2 if required to control temperature of mass concrete and hot weather concrete.

- F. Sheet Curing Materials: Waterproof paper (regular or white), polyethylene film (clear or opaque white), and white burlap-polyethylene sheet complying with AASHTO M171.
- G. Chemical Hardener: All exposed concrete floor slabs shall be hardened with three applications of fluosilicate chemical hardener followed by two applications of clear acrylic concrete sealer by Sonneborn Division, ChemRex Inc. "Lapidolith"; or equal products by W.R. Meadows Co. and Concrete Service Material Company or other manufacturers.
- H. Penetrating Sealer: Monomeric alkyalkoxy silane sealer which has demonstrated penetrability into dry low permeability concrete to a minimum of 1/4 inch. Sealer shall have 20 to 25 percent solids when used on walls, and 40 to 50 percent solids when used on floors.
- I. Epoxy Membrane Curing Compound/Concrete Sealer: The two component, epoxy resin system shall act as a dual purpose material: A membrane compound for curing alone, plus a penetrating sealer. It shall provide protection for concrete exposed to de-icing salts, commercial acids and alkalis, gasoline, diesel fuel, and oil, and exposure to freeze/thaw cycles and to vehicular traffic. The epoxy resin compound shall be furnished in two components for combining immediately prior to use in accordance with the manufacturer's written instructions as specified herein. The components of the epoxy resin system shall conform to the following requirements.
 - 1. Component A: Poly (2 hydroxypropylene, P'p, isopropylidenephenolate) condensed with 1 chlorepropoxirane such that the ox content is 4% in aralkyl and hydroxylated solvents. Component B: The amido amine condensate of the Diels Alder adduct of polyunsaturated acids dissolved in suitable solvents. Ratio of components (A to B): 1:1 by volume.
 - 2. Properties of Mixed Material:
 - a. Viscosity: 75 to 125 cP's at 75°F.
 - b. Pot Life: 8 hours minimum at 75°F.
 - c. Minimum Solids Content: 40 to 44% by weight.
 - d. Recoat Time: 24 hours maximum.
 - e. Dry Film Thickness: 2 to 3 mils per coat.
 - f. Color: Clear, White tint, gray tint.
 - 3. Properties of Cured Material:
 - a. The cured system shall exhibit no evidence of a mine blushing or sweating which may inhibit bond of subsequent coats.
 - b. When tested according to ASTM D 968, specimens of coating cured for 14 days at 75°F shall exhibit an abrasion coefficient of at least 30 liters per mil.
 - c. When tested according to ASTM D 522, a 2 mil dry film thickness specimen cured for 14 days at 75° shall exceed 12% elongation when tested on the 1/4 inch mandrel.
 - d. Specimens cured for 14 days at 75°F and immersed for 48 hours shall exhibit less than 1% water absorption by weight.
 - e. Water Retentivity shall not exceed 0.055 grams per square centimeter when tested according to ASTM C 156.

3.5 METAL PANEL INSTALLATION

- A. General: Install panels in orientation, sizes, and locations indicated on Drawings. Install panels perpendicular to girts and subgirts, unless otherwise indicated. Anchor metal wall panels and other components of the Work securely in place, with provisions for thermal and structural movement.
- B. Field cutting of metal panels by torch is not permitted. Shim or otherwise plumb substrates receiving metal panels. Rigidly fasten base end of metal panels and allow eave end free movement due to thermal expansion and contraction. Predrill panels. Install screw fasteners in predrilled holes. Locate and space fastenings in uniform vertical and horizontal alignment. Install flashing and trim as metal panel work proceeds

3.6 FLASHING MEMBRANE INSTALLATION

- A. Metal Edge Detail
 - 1. See details for scuppers. For manufactured edge metal, scuppers shall be factory fabricated.
 - 2. Accessories: Joint covers, corners, supports, strip flashing at joining, fastenings and other accessories shall be included.
 - 3. Install continuous cleat fasten 6" O.C. Fasten flange to wood nailer every 6" staggered.
 - 4. Install new metal edge hooked to continuous cleat.
 - 5. Prime metal edge at a rate of 100 square feet per gallon and allow to dry.
- B. Coping Cap/ Surface Mounted Counter-flashing
 - 1. Copings shall be provided with factory fabricated welded watertight coping accessories such as miters, transitions, end caps, etc. and finished to match coping system.
 - 2. Accessories: Joint covers, corners, supports, strip flashing at joinings, fastening, and other accessories shall be included.
 - 3. Install continuous cleat fasten 6" O.C.
 - 4. Install new coping cap hooked to continuous cleat.

PART 4 - MEASUREMENT AND PAYMENT

4.1 GENERAL

- A. Separate Measurement and Payment will not be made for work required under this Section, but all costs in connection, therefore, will be included in the Contract Lump Sum Price for Item No. 745.01 – Bus Rapid Transit Stations.

END OF SECTION

SECTION 07920

JOINT SEALANTS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Work Included:** This Section specifies Joint sealants and fillers for exterior applications applied to expansion joint surfaces of cast-in-place concrete elements.
- B. Related Work:** The following items are not included in this Section and will be performed under the designated Sections:
 - 1. Section 03300 – CAST-IN-PLACE CONCRETE**
 - 2. Section 09360 – MODULAR TACTILE SURFACES**

1.2 PERFORMANCE REQUIREMENTS

- A. Provide elastomeric joint sealants that establish and maintain watertight and airtight continuous joint seals without staining or deteriorating joint substrates.**

1.3 SUBMITTALS

- A. Product Data:** For each joint-sealant product indicated.
- B. Samples for Verification:** For each type and color of joint sealant required, provide Samples with joint sealants in 1/2-inch wide joints formed between two 6-inch long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.
- C. Qualification Data:** For Installer.
- D. Preconstruction Field Test Reports:** Indicate which sealants and joint preparation methods resulted in optimum adhesion to joint substrates based on preconstruction testing specified in Part 1 "Quality Assurance" Article.
- E. Compatibility and Adhesion Test Reports:** From sealant manufacturer, indicating the following:
 - 1. Materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with joint sealants.**
 - 2. Interpretation of test results and written recommendations for primers and substrate preparation needed for adhesion.**
- F. Field Test Report Log:** For each elastomeric sealant application.

- G. **Product Test Reports:** Based on comprehensive testing of product formulations performed by a qualified testing agency, indicating that sealants comply with requirements.

1.4 QUALITY ASSURANCE

- A. **Installer Qualifications:** Manufacturer's authorized Installer who is approved or licensed for installation of elastomeric sealants required for this Project.
- B. **Source Limitations:** Obtain each type of joint sealant through one source from a single manufacturer.
- C. **Preconstruction Compatibility and Adhesion Testing:** Submit to joint-sealant manufacturers, for testing indicated below, samples of materials that will contact or affect joint sealants.
 - 1. Use manufacturer's standard test method to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.
 - 2. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
 - 3. For materials failing tests, obtain joint-sealant manufacturer's written instructions for corrective measures including use of specially formulated primers.
 - 4. Testing will not be required if joint-sealant manufacturers submit joint preparation data that are based on previous testing of current sealant products for adhesion to, and compatibility with, joint substrates and other materials matching those submitted.
- D. **Preconstruction Field-Adhesion Testing:** Before installing elastomeric sealants, field test their adhesion to Project joint substrates as follows:
 - 1. Locate test joints where indicated on Project or, if not indicated, as directed by Engineer.
 - 2. Conduct field tests for each application indicated below:
 - a. Each type of elastomeric sealant and joint substrate indicated.
 - b. Each type of nonelastomeric sealant and joint substrate indicated.
 - 3. Notify Engineer seven days in advance of dates and times when test joints will be erected.
 - a. **Test Method:** Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1 in ASTM C 1193.
 - 1) For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.
 - 4. Report whether sealant in joint connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each

type of product and joint substrate. For sealants that fail adhesively, retest until satisfactory adhesion is obtained.

5. **Evaluation of Preconstruction Field-Adhesion-Test Results:** Sealants not evidencing adhesive failure from testing, in absence of other indications of noncompliance with requirements, will be considered satisfactory. Do not use sealants that fail to adhere to joint substrates during testing.

E. Preinstallation Conference: Conduct conference at Project site prior to installation.

1.5 PROJECT CONDITIONS

A. Do not proceed with installation of joint sealants under the following conditions:

1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F.
2. When joint substrates are wet.
3. Where joint widths are less than or greater than those allowed by joint-sealant manufacturer for applications indicated.
4. Contaminants capable of interfering with adhesion have not yet been removed from joint substrates.
5. When substrates have not cured sufficiently.

1.6 WARRANTY

A. Special Installer's Warranty: Installer's standard form in which Installer agrees to repair or replace elastomeric joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. **Warranty Period:** Five years from date of Substantial Completion.

B. Special Manufacturer's Warranty: Manufacturer's standard form in which elastomeric sealant manufacturer agrees to furnish elastomeric joint sealants to repair or replace those that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. **Warranty Period:** Five years from date of Substantial Completion.

C. Special warranties specified in this Article exclude deterioration or failure of elastomeric joint sealants from the following:

1. Movement of the structure resulting in stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression caused by structural settlement or errors attributable to design or construction.
2. Disintegration of joint substrates from natural causes exceeding design specifications.
3. Mechanical damage caused by individuals, tools, or other outside agents.
4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

- A. **Compatibility:** Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by sealant manufacturer, based on testing and field experience.
- B. **VOC Content of Interior Sealants:** Provide interior sealants and sealant primers that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
 - 1. Sealants: 250 g/L.
 - 2. Sealant Primers for Nonporous Substrates: 250 g/L.
 - 3. Sealant Primers for Porous Substrates: 775 g/L.
- C. **Colors of Exposed Joint Sealants:** As indicated by manufacturer's designations.

2.2 JOINT SEALANTS

- A. **Elastomeric Sealants:** Comply with ASTM C 920 and other requirements indicated for each liquid-applied chemically curing sealant specified, including those referencing ASTM C 920 classifications for type, grade, class, and uses related to exposure and joint substrates.
- B. **Stain-Test-Response Characteristics:** Elastomeric sealants shall be nonstaining to porous substrates. Provide products that have undergone testing according to ASTM C 1248 and have not stained porous joint substrates indicated for Project.
- C. **Single-Component Neutral-Curing Silicone Sealant:**
 - 1. **Available Products:** Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Dow Corning Corporation; 790.
 - b. GE Silicones; SilPruf LM SCS2700.
 - c. Tremco; Spectrem 1.
 - d. Pecora Corporation; 864.
 - 2. **Extent of Use:** Joints in exterior vertical and soffit surfaces.
- D. **Multicomponent Pourable Urethane Sealant:**
 - 1. **Available Products:** Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Bostik Findley; Chem-Calk 550.
 - b. Meadows, W. R., Inc.; POURTHANE.
 - c. Pecora Corporation; Urexpan NR-200.
 - d. Tremco; THC-901.

2. Extent of Use: Joints in exterior horizontal surfaces.

E. Single-Component Mildew-Resistant Acid-Curing Silicone Sealant:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

- a. Dow Corning Corporation; 786 Mildew Resistant.
- b. GE Silicones; Sanitary SCS1700.
- c. Tremco; Tremsil 200.

2. Extent of Use: Sanitary joints at toilet rooms.

F. Latex Sealant: Comply with ASTM C 834, Type P, Grade NF.

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

- a. Bostik Findley; Chem-Calk 600.
- b. Pecora Corporation; AC-20+.
- c. Sonneborn, Division of ChemRex Inc.; Sonolac.
- d. Tremco; Tremflex 834.

2.3 JOINT-SEALANT BACKING

- A. General: Provide sealant backings of material and type that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.**
- B. Cylindrical Sealant Backings: ASTM C 1330, Type C (closed-cell material with a surface skin). O (open-cell material). B (bicellular material with a surface skin) or any of the preceding types, as approved in writing by joint-sealant manufacturer for joint application indicated, and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance:**
- C. Elastomeric Tubing Sealant Backings: Neoprene, butyl, EPDM, or silicone tubing complying with ASTM D 1056, nonabsorbent to water and gas, and capable of remaining resilient at temperatures down to minus 26 deg F. Provide products with low compression set and of size and shape to provide a secondary seal, to control sealant depth, and to otherwise contribute to optimum sealant performance.**
- D. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint where such adhesion would result in sealant failure. Provide self-adhesive tape where applicable.**

2.4 MISCELLANEOUS MATERIALS

- A. **Primer:** Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.
- B. **Cleaners for Nonporous Surfaces:** Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.
- C. **Masking Tape:** Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. **Surface Cleaning of Joints:** Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:
 - 1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
 - 2. Clean porous joint substrate surfaces by brushing, grinding, blast cleaning, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include concrete, masonry and unglazed surfaces of ceramic tile.
 - 3. Remove laitance and form-release agents from concrete.
- B. **Joint Priming:** Prime joint substrates, where recommended in writing by joint-sealant manufacturer, based on preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

- C. **Masking Tape:** Use masking tape where required to prevent contact of sealant with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION OF JOINT SEALANTS

- A. **General:** Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.
- B. **Sealant Installation Standard:** Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- C. **Install sealant backings of type indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.**
 - 1. Do not leave gaps between ends of sealant backings.
 - 2. Do not stretch, twist, puncture, or tear sealant backings.
 - 3. Remove excess material.
 - 4. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.
- D. **Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.**
- E. **Install sealants using proven techniques that comply with the following and at the same time backings are installed:**
 - 1. Place sealants so they directly contact and fully wet joint substrates.
 - 2. Completely fill recesses in each joint configuration.
 - 3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
 - 4. Install in uniform continuous ribbons without gaps or air pockets.
- F. **Tooling of Nonsag Sealants:** Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
 - 1. Remove excess sealant from surfaces adjacent to joints.
 - 2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
 - 3. Provide concave joint configuration per Figure 5A in ASTM C 1193, unless otherwise indicated.

3.4 REPAIR AND CLEANING

- A. **Remove damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.**

- B. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.5 PROTECTION

- A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

PART 4 - MEASUREMENT AND PAYMENT

4.1 GENERAL

- A. Separate measurement and payment will not be made for work under this Section complete in place, but all costs in connection therefore shall be included in the items of work to which they pertain.

END OF SECTION

SECTION 08801
GLASS AND GLAZING

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Work Included: This Section specifies the following items.
1. Glass and glazing for the following products and applications:
 - a. Tempered safety laminated glass panels at station canopy roofs; including metal supports and point supports.
 - b. Tempered safety laminated glass panels at platform passenger shelters
 - c. Tempered safety laminated glass panels at station signage
- B. Related Work: The following items are not included in this Section and will be performed under the designated Sections:
1. Section 05500 – Miscellaneous Metals
 2. Section 07600 – Flashing and Sheet Metals

1.2 DEFINITIONS

- A. Manufacturers of Glass Products: Firms that produce primary glass, fabricated glass, or both, as defined in referenced glazing publications.
- B. Glass Thicknesses: Indicated by thickness designations in millimeters according to ASTM C 1036.
- C. Deterioration of Coated Glass: Defects developed from normal use that are attributed to the manufacturing process and not to causes other than glass breakage and practices for maintaining and cleaning coated glass contrary to manufacturer's written instructions. Defects include peeling, cracking, and other indications of deterioration in metallic coating.
- D. Deterioration of Insulating Glass: Failure of hermetic seal under normal use that is attributed to the manufacturing process and not to causes other than glass breakage and practices for maintaining and cleaning insulating glass contrary to manufacturer's written instructions. Evidence of failure is the obstruction of vision by dust, moisture, or film on interior surfaces of glass.
- E. Deterioration of Laminated Glass: Defects developed from normal use that are attributed to the manufacturing process and not to causes other than glass breakage and practices for maintaining and cleaning laminated glass contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standard.

2. Fabricate from pan-formed porcelain enameled steel plate with flat-flanged edges. All forming shall be mechanical and done in advance of welding.
 3. Precisely form work to sizes, shapes, and profiles indicated on approved shop drawings. Fabricate work with uniform joints that are not visible. Work to be truly straight, plumb, level and square with smooth flat surfaces and sharp corners
 4. All welds shall be clean, sound and solid, free from defects and gas bubbles, and ground and sanded smooth to 3/16" to match the 3/16" radii of the mechanical break. They shall be done using a hand oxyacetylene fusion technique with no additions of foreign metals.
 5. All necessary holes and cutouts shall be drilled or punched and welded in advance of enameling, with edges sufficiently ground to hold a porcelain coating.
 6. Fabricate laminated sandwich construction, consisting of front sheet of porcelain enameled steel plate, on a 1/2 in. thick Marine Grade plywood core, with a layer of galvanized steel backing.
- B. Aluminum Signs
1. Coordinate dimensions and attachment methods to produce message panels with closely fitting joints. Align edges and surfaces with one another in the relationship indicated.
 2. Continuously weld joints and seams, unless other methods are indicated; grind, fill, and dress welds to produce smooth, flush, exposed surfaces with welds invisible after final finishing.
 3. Provide concealed sealing of joints to exclude water and provide corrosion protection, exclude sealing of joints where drainage of moisture will be inhibited, and do not seal weep holes. Seal joints with specified sealers, and for exposed sealers, provide color to match finish. Provide joint sealers tested for adhesion and compatibility with specified materials and finishes.
 4. Mounting Method: Provide members with pins of length shown for installation weld to base plates or mechanically fasten where shown unless otherwise indicated. Provide turned pins and other anchorage provisions to resist vandalism and theft.

PART 3 - EXECUTION

3.1 INSPECTION

- A. The Installer shall examine substrates, supports, and conditions under which this work is to be performed, and notify the Contractor and the Architect in writing of conditions detrimental to the proper completion of the work. Do not proceed with work until unsatisfactory conditions are corrected. Beginning work means Installer accepts substrates and conditions.
- B. Notification Point: The Architect and MBTA Design and Construction Department will be given 72 hour notice to perform field inspection at the start of installation of signage. If work does not meet project requirements, contractor must remove and replace deficient work.

3.2 INSTALLATION/APPLICATION/ERECTION

- A. All locations where signs are to be installed new or retrofitted to existing frames must be field measured by contractor. This must be documented and sent to the MBTA Design and Construction Department prior to final digital artwork submittal and fabrication of signage.
- B. Strictly comply with approved shop drawings and manufacturer's instructions and recommendations, except where more restrictive requirements are specified in this Section.

- C. Install work plumb, level, and in true plane and alignment. Provide signs and graphics where shown or scheduled using mounting methods indicated.
- D. Protect adjacent or adjoining surfaces and work from damage during installation in this Section.
- E. Work shall be designed and anchored so that work will not be distorted nor the fasteners overstressed from expansion and contraction of metal or other materials as applicable.

3.3 TOLERANCES

- A. The following installed tolerances are allowable variations from locations and dimensions indicated by the Contract Document and shall not be added to allowable tolerances indicated for other work:
 1. Allowable Variation from True Plumb, Level and Line: Plus or minus 1/32 inch from true position for signage smaller than 24 by 24 inches in size; plus or minus 1/16 inch from true position for signage 24 by 24 inches in size and larger.
 2. Allowable Variation from True Plane of Adjacent Surfaces: Plus or minus 1/16 inch.

3.4 CLEANING AND PROTECTION

- A. Adjust work to present the best possible appearance. Touch-up damaged finishes and eliminate any evidence of repair. Clean exposed surfaces using materials and methods recommended by manufacturer of material or product being cleaned. Remove and replace work that cannot be successfully repaired or cleaned.
- B. Provide temporary protection to ensure work is delivered without damage or deterioration at time of final acceptance. Remove protections and reclean as necessary immediately before final acceptance.
- C. Manufacturer shall provide Authority with information on cleaning and maintenance recommendations for all signs.
- D.** Names, stamps and decals of manufacturers, installers or maintainers of signs shall not be visible in the finished work.

3.5 TEMPORARY SIGNAGE

A. After sign and map frames are installed and porcelain enamel wayfinding signage is field measured and ordered, if porcelain enamel lead time prevents wayfinding signage from being installed in time for BRT Station openings, then the Contractor shall perform the following (note the following applies to Maps also. Maps will not be Porcelain enamel but will be vinyl on the below aluminum metal pans as their permanent condition):

- 1. Fabricate aluminum (.063 thickness) pans after field measuring signage/map frames.**
- 2. Deliver fabricated aluminum pans to MBTA Sign shop located at 21 Arlington Ave., Charlestown, MA 02129**
- 3. MBTA Sign Shop Personnel will apply vinyl signage and maps to aluminum pans.**
- 4. Contractor will pick up aluminum pans with vinyl signage / maps applied to them from MBTA sign shop.**
- 5. Contractor will install aluminum pans with vinyl signage / maps applied to them in the field.**

- 6. When Porcelain Enamel wayfinding signage is delivered, Contractor to replace temporary vinyl wayfinding signage with permanent porcelain enamel signage.**

PART 4 - MEASUREMENT AND PAYMENT

4.1 GENERAL

- A. Separate Measurement and Payment will not be made for work required under this Section, but all costs in connection, therefore, will be included in the Contract Lump Sum Price for Item No. 745.01 – Bus Rapid Transit Stations. The lump sum price shall include all materials, labor, tools and equipment incidental and necessary for the installation, complete in place, of all fixed signage for the BRT Stations.

END OF SECTION

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**SECTION 10450
FARE COLLECTION EQUIPMENT
PART 1 – GENERAL**

1.01 DESCRIPTION

- A. This Section specifies the installation of Fare Collection Equipment at all locations shown on the Contract Drawings for the Silver Line extension to Chelsea. Scheidt & Bachmann (S&B) will be responsible for manufacturing, supplying, delivering to the site, testing, and commissioning of the new fare collection equipment to be installed by the Contractor as shown on the contract drawings and described herein. The Contractor is responsible to receive, install, run conduit/cable, apply terminations, and test cable/terminations and be available as may be needed during cutover and commissioning of systems.
- B. The Fare Collection equipment to be installed at the various locations includes, but is not limited to the following:
 - 1. Cash/Credit/Debit/Full Service fare vending machines (FVMs)
 - 2. Cashless FVMs
 - 3. Fare Media Validators (FMVs)
 - 4. Networking equipment such as switches, media converters, etc.
 - 5. Any other equipment deemed necessary to complete a fully functional AFC system
- C. Work under this section also includes work under Section 16749, and 16050.
- D. **Information regarding the installation of the Cash & Card Fare Vending Machines (FVM) and the Fare Media Validators (FMV) are indicated in the Maintenance Manuals included at the end of this Section 10450.**

1.02 QUALITY ASSURANCE

- A. Maintain records of all test and inspection work securely and complete, and keep them available to the Authority during the performance of the Contract.
- B. Materials, suppliers, and products shall be subject to inspection to the extent necessary to ensure conformance to technical requirements.
- C. If any damage, defect, error, or inaccuracy is found in any material, component, or any part/parts of the work, the Engineer will have the right either to reject the work or to require correction of the work, which shall be done by, and at the expense of, the Contractor. No separate payment will be made.

1.03 SUBMITTALS

- A. The Contractor shall prepare and submit to the Engineer for approval, six complete sets of shop drawings with calculations stamped and signed by a State of Massachusetts Registered Structural Professional Engineer. Shop drawings shall indicate the installation of all equipment, showing locations, fasteners, reinforcements, base plates, details of fabrication, size of members, finishes and all other components that are part of the Fare Collection equipment installation as shown on the contract drawings, and reference documents supplied by the equipment supplier. Fasteners shall be checked using loading information supplied by the equipment manufacturer.
- B. Indicate by reference on the drawings the Specification Section number, title, article number and Contract Drawing and sheet number to which the shop drawing pertains. The Contractor shall not fabricate any material or proceed with any equipment installation work until approval of the shop drawings has been obtained. Deviations from the design or reference documents as shown on the Contract Drawings shall be distinctly indicated on shop drawings. Submittal of shop drawings shall comply with the procedures included in these Specifications.
- C. Contractor shall submit their proposed delivery documentation and procedures based on information contained within these specifications.

1.04 DELIVERY

- A. Shipment of the equipment from the equipment supplier's facility or from the warehouse to the installation site shall be the responsibility of the equipment supplier. The Contractor shall coordinate with the Engineer to take delivery of the Fare Collection equipment to be installed.
- B. The equipment supplier is required by MBTA to notify the Engineer at least 10 days prior to any intended shipment. The Contractor shall define details of delivery such as exact address, delivery date and time, number and type of equipment to be delivered. The MBTA engineer shall provide an onsite contact name and number to be responsible for receiving the shipment from S&B.
- C. Equipment is to be delivered to curbside of the station entrance. The delivery location is fixed unless otherwise agreed to between the Contractor, S&B, and the MBTA.
- D. The Contractor shall be responsible for all arrangements that are needed for the equipment supplier to access the delivery site and deliver the equipment. The Contractor's responsibility includes but is not limited to making the delivery area available (e.g. snow removal and free space), securing the area (e.g. posting hazard signs if necessary).
- E. The Contractor will receive the equipment securely crated and properly labeled. The Contractor and an MBTA representative shall check against the Bill of Material (BOM) against equipment received, inspect the equipment for any visible damage to packaging and crating and note any damage on the delivery receipt form.
- F. The Contractor is responsible for protecting the equipment after delivery has been made. Transportation from the delivery truck to the installation place and any associated safety precautions for drop-off, transportation and/or interim storage will be the responsibility of the Contractor. The Contractor shall adequately support, block, strap, or otherwise protect components during movement after shipment. Fare collection equipment must remain covered and protected from any environmental or construction debris while in storage awaiting installation.
- G. For equipment delivery, the equipment supplier will provide standard shipment papers to the recipient with sign-off sheets for documentation purposes. If the Contractor requires any special handling documentation, they will need to provide the pertinent information to the equipment supplier prior to shipment.
- H. The Contractor shall be responsible for providing any means or resources to protect public safety or to secure the system including those that may be needed during unloading of the truck at the curbside during delivery of the equipment as well as during the storage period prior to installation.

PART 2 – PRODUCTS

2.01 GENERAL A.

- A. Cable, conduit, and under floor duct to be provided shall be in accordance with Sections 16050 Basic Materials and Methods for Electrical Work and 16749 Fiber Optic Cable System and the cable details table provided in the S&B reference installation instructions and drawings.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. S&B and MBTA representatives will attend site inspections conducted by the MBTA Project Manager to confirm completion of site preparation prior to equipment placement.
- B. All material and apparatus specified herein shall be installed in accordance with the Contract Documents, which include the manufacturer's instructions and recommendations, and in accordance with the Contractor's approved plans.
- C. Installation hardware to be provided by S&B includes floor anchor rods/bolts/washers, etc, supplies for leveling and sealing, insulation caps for holes in bases of FVMs that feed incoming wires where holes are not used and need to be sealed, and installation templates for all equipment types.
- D. All Fare Collection equipment shall be mounted and leveled in accordance with the S&B installation instructions and drawings.
- E. Installation hardware delivered by the equipment supplier does not include: standard tools, power supply cables to equipment, communication cables to equipment, wire raceways and tubes to the equipment for incoming power and communication cable, cables between adjacent equipment, ferrules and fiber connectors and supplies to terminate incoming power and communications cables.
- F. Contractor shall install power wiring from the power distribution panel to Fare Collection equipment, in accordance with the Contract Drawings, manufacturer's recommendations, and the requirements of these Specifications. Connections at the power distribution panel shall be made by the Contractor.
- G. Contractor will be responsible to install communications cable (Fiber Optic or CAT5/CAT6) from the fiber or network termination patch panels to the Fare Collection equipment, and the wide area network termination point within the communications room or bungalow as approved by the MBTA in accordance with Contract Drawings, manufacturer's recommendations, and requirements of these Specifications.

- H. Contractor will be responsible for termination of wiring to Fare Collection devices. MBTA representatives and Contractor will participate in startup testing to determine that all installed equipment powers up and connections are correct.
- I. The Contractor is responsible to apply cable connectors where required and shall then test cables and connectors in accordance with the applicable section of these specifications. The contractor shall submit suitable cable test reports to the Engineer.
- J. S&B shall connect test and perform final commissioning of all fare collection devices and associated equipment. Special Test Requirements for the Contractor are described within the equipment installation instructions provided herein.

3.02 STANDARDS

- A. The installation of the Fare Collection equipment shall comply with:
 - 1. The applicable regulations of the Massachusetts State Building Code, Massachusetts Architectural Access Board, and the latest Massachusetts Electrical Code.
 - 2. The applicable regulations of the latest National Electrical Code.
- B. All electrical materials shall be listed by the Underwriters Laboratories, Inc. as conforming to its standards in every case where a standard has been established for the particular material type.

3.03 TESTING OF COMPLETED ASSEMBLIES

- A. The Contractor shall be responsible to energize all installed equipment. S&B and MBTA will commission and test for proper function and operation.
- B. The Contractor shall terminate the power and data cable provided and installed to the fare collection equipment termination points. Proper labeling of cables, connectors or conductors by the Contractor is required. S&B shall ensure that records provided by the Contractor indicate that the electrical grounding, the power cable protection and the communication capability between the data demarcation points of the field devices and the Central Computer System have been tested and documented by the Contractor prior to the commissioning.
- C. The Contractor is responsible for testing of power and communications wire and cable. All tests shall be performed in accordance with the applicable Sections of these specifications.
- D. S&B shall be responsible to perform all communications testing to confirm proper data exchange on all installed equipment, once connections are terminated.
- E. After installation of the Fare Collection equipment, the equipment supplier shall perform an Installation Inspection Test on each unit installed to confirm that the equipment is properly installed and interfaces properly with the AFC Central Computer system. All cable tests conducted by the Contractor shall be recorded and those records shall be provided to the MBTA and the equipment supplier prior to commencement of the Installation Inspection Test. S&B inspect all installed equipment for the following:

1. Quality of installation
2. Damage to equipment
3. Missing components and parts
4. Correct power and communication connections
5. Correct positioning and mounting

Installations failing to meet the requirements of S&B's reference installation document shall be corrected by the Contractor at no additional cost to the Authority.

- F. The Contractor shall be available during functional testing and commissioning to correct any deficiencies that are the result of work performed by the Contractor.
- G. Commissioning of the Fare Collection equipment is the responsibility of S&B and the MBTA representatives and shall be commenced after receipt of the wiring test records from the Contractor. The MBTA shall be a witness to the Installation Inspection Test in order to avoid any doubt with respect to the cause of possible damages or inappropriate performance of work.
- H. The equipment supplier's commissioning in this context will consist of inspection of proper placement of all inner subcomponents, energizing of the equipment, function test, and communications test. The Contractor shall coordinate with the equipment supplier and the MBTA for the details of the test duration.
- I. Any system deficiencies observed under testing of the Fare Collection equipment shall be noted by the equipment supplier in the certified test report. The Contractor shall provide a new test report for repaired equipment for which the Contractor is responsible after all deficiencies are corrected and the system has been retested.
- J. The MBTA's designated representative shall witness all inspections and tests. Commissioning and Installation Inspection will be conducted in parallel therefore the availability of the MBTA's witnesses is required throughout its execution.

PART 4 – MEASUREMENT AND PAYMENT

4.01 GENERAL

- A. Separate Measurement and Payment will not be made for work required under this Section, but all costs in connection, therefore, will be included in the Contract Lump Sum Price for Item No. 745.01 – Bus Rapid Transit Station. The lump sum price shall include all labor, tools and equipment incidental and necessary for the installation, complete in place, of the Fare Collection Equipment at the BRT Stations.

END OF SECTION

VOLUME 1 – Chapter 11 CCFVM Installation

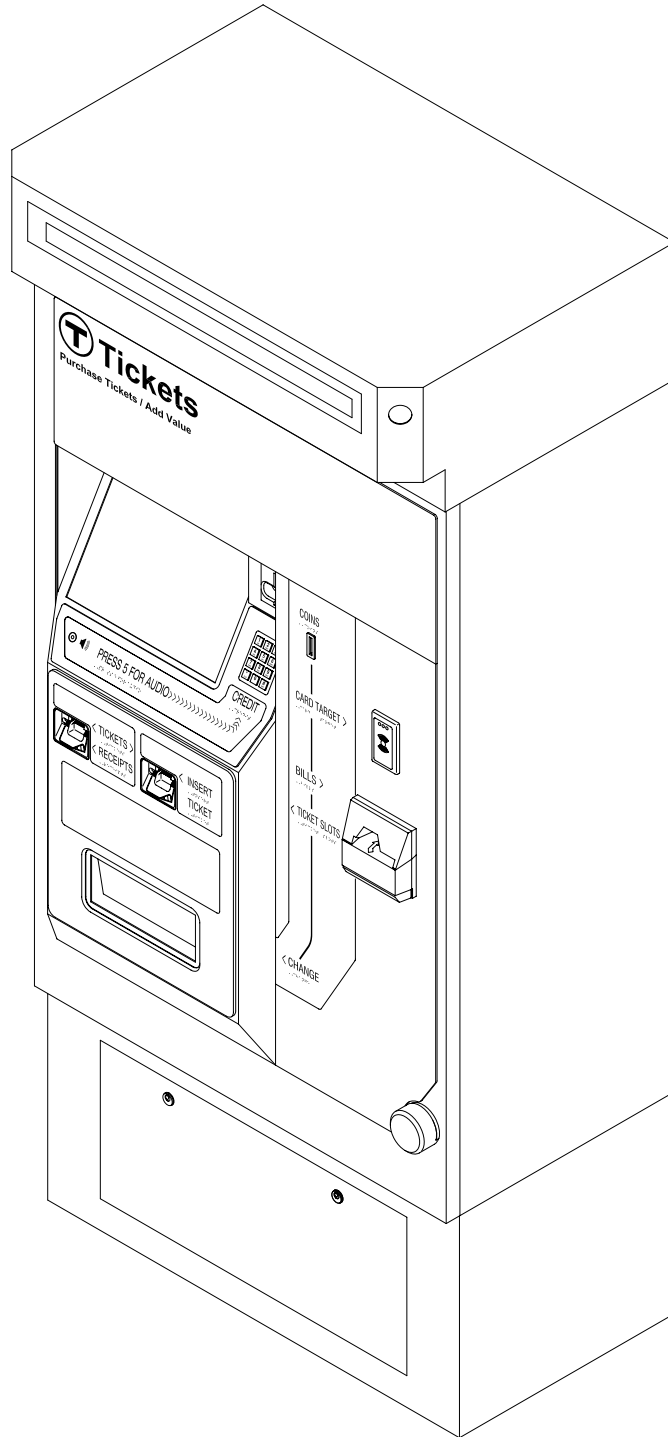


Figure 11-1 Cash & Card Fare Vending Machine (CCFVM)

**11.1 CCFVM
Installation:
General
description**

The following information is provided for use by anyone undertaking the installation of Cash & Card Fare Vending Machines (CCFVMs). Detailed descriptions and drawings may be found throughout this chapter.

- When packaged for shipment, CCFVMs are secured to two transport four by fours.
- The two transport four by fours are secured to a shipping pallet (skid).
- The CCFVM must always be transported in the upright position.
- Use a pallet lifter for transport.
- Use a Machinery Mover for transport on stairs.
- To avoid damage, deliver CCFVMs to the installation location in the original Scheidt & Bachmann packaging.

The following warnings should be heeded as well.



***Three or more people should transport and install each CCFVM.
Do not drop or bang the CCFVM!***



NOTE: The CCFVM can tip over. Never allow the CCFVM to tip over. It must be kept upright and transported to its installation location upright.

Ensure that there is no power on any cable before starting installation. Breakers must be shut off and all data cabling should be disconnected.

An electrician installs power cables near the terminal strips in the Pedestal.



An authorized Scheidt & Bachmann electrical worker will connect the power cables.

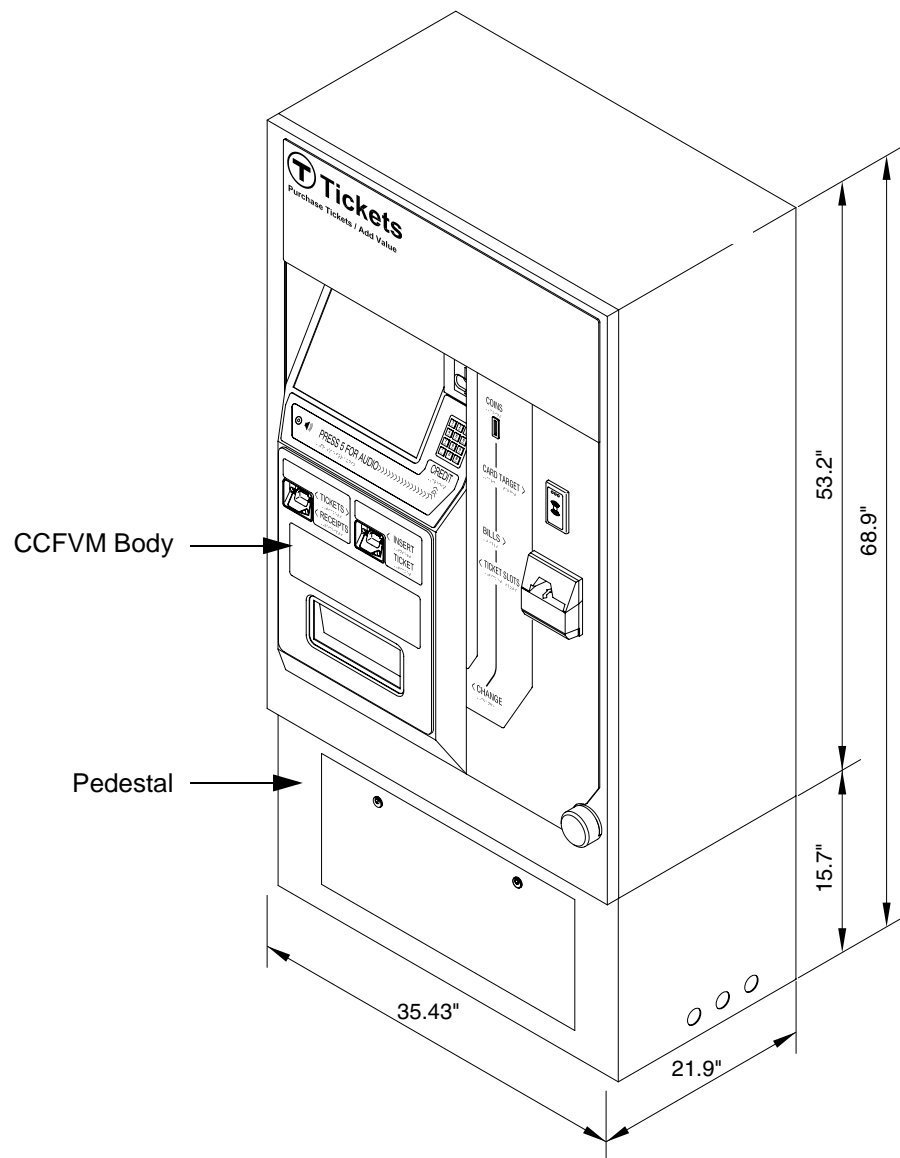
An authorized Scheidt & Bachmann communications worker will connect the communication cable.

**11.2 Dimensions
and Weight**

CCFVM	CCFVM Unpacked	CCFVM Packed
Width	35.4"	Approximately 44"
Height	53.2"	Approximately 63"
Depth	21.9"	Approximately 31"
Weight	Approximately 551 lbs.	Approximately 591 lbs

Table 11-1 CCFVM Dimensions and Weight

Pedestal	CCFVM Unpacked	CCFVM Packed
Width	35.4"	Approximately 44"
Height	15.7"	Approximately 26"
Depth	18.5"	Approximately 29"
Weight	Approximately 60 lbs.	Approximately 80 lbs

Table 11-2 Pedestal Dimensions and Weight**Figure 11-2** CCFVM Dimensions

11.3 Power consumption

Power	Units	CCFVM with Heating Off	CCFVM with Heating On
Power	Watts	500	1,000
Current	Amperes A	4.2	8.3
Peak input current: 25 A			
Input voltage for CCFVM is specified with nominal 120VAC \pm 10%, 3 wire, 60 Hz \pm 1.0%. A 10 Amp circuit breaker for the service outlet is installed at Terminal Block TB1.			

Table 11-3 CCFVM Power Consumption

11.4 Site Placement Factors

The design of the installation location is important. The Transit Authority, station architect, and installers are responsible for:

- Adhering to historic site preservation regulations.
- Ensuring that clearance and access requirements are met.
- Taking weather into consideration when transporting and installing CCFVMs.
- Checking stairways for soundness and weight-bearing.
- Checking elevators for size, capacity, and weight-bearing capability.
- Ensuring the weight-bearing capability of the installation site floor.
- Ensuring the security of the installation site from preparation to completion of installation.

Scheidt & Bachmann understands there are federal and state historic site preservation regulations. Many of the communities in the Transit Authority region may have historic preservation committees that have a voice in any changes to historic buildings. The Transit Authority, station architect, and installers are responsible for these matters.



Ensure clearance and access requirements are met!

Ensure compliance with ADA requirements!

Consider weather when deciding the placement of CCFVMs!

Ensure stairways are of sound construction and meet weight-bearing requirements!

Ensure elevators have the necessary size, capacity, and weight-bearing capabilities!

Ensure the security of the installation site!

**11.4.1 CCFVM
Mounting
Issues**

During transportation and when an CCFVM is installed but not operational, the environmental and storage conditions of **Table 11-3** must be met. The requirements for CCFVM mounting must be met. Observing these requirements is the responsibility of the Transit Authority, station architect, and installers. Minimum clearances between CCFVMs, minimum distances from obstructions, placement in a convenient location for patrons but out of the flow of pedestrian traffic, and placement where temperature extremes, sunlight, and weather conditions do not hamper any patron's use of the machines, are all considerations that should be foremost in the minds of those planning, and actually performing, the installation.

Environmental Condition	Acceptable Range
Ambient Temperature	14 °F to 158 °F (-10 °C to 70 °C)
Temperature Fluctuations	Up to +/- 18 °F (10 °C) in 2 hours
Relative Humidity	80 % max. non-condensing
Altitude	-200 ft to 40,000 ft

Table 11-4 Environmental Ranges

In particular, the Message Display Unit (MDU), which is the primary means of communication with patrons, should be properly protected from rain, snow, freezing precipitation, or direct sunlight. **Table 11-3** environmental and storage conditions apply when the CCFVM is installed, but not operational.



Rain, snow, and freezing precipitation will cause operational problems!

Placing a CCFVM in direct sunlight will hinder the patron's use of the screen!

Environmental and storage conditions must be observed!

11.4.2 Installation

When installing CCFVMs, the following clearances must be provided (refer to S&B 83 01942, MBTA 158601 full-size drawing for clarity).

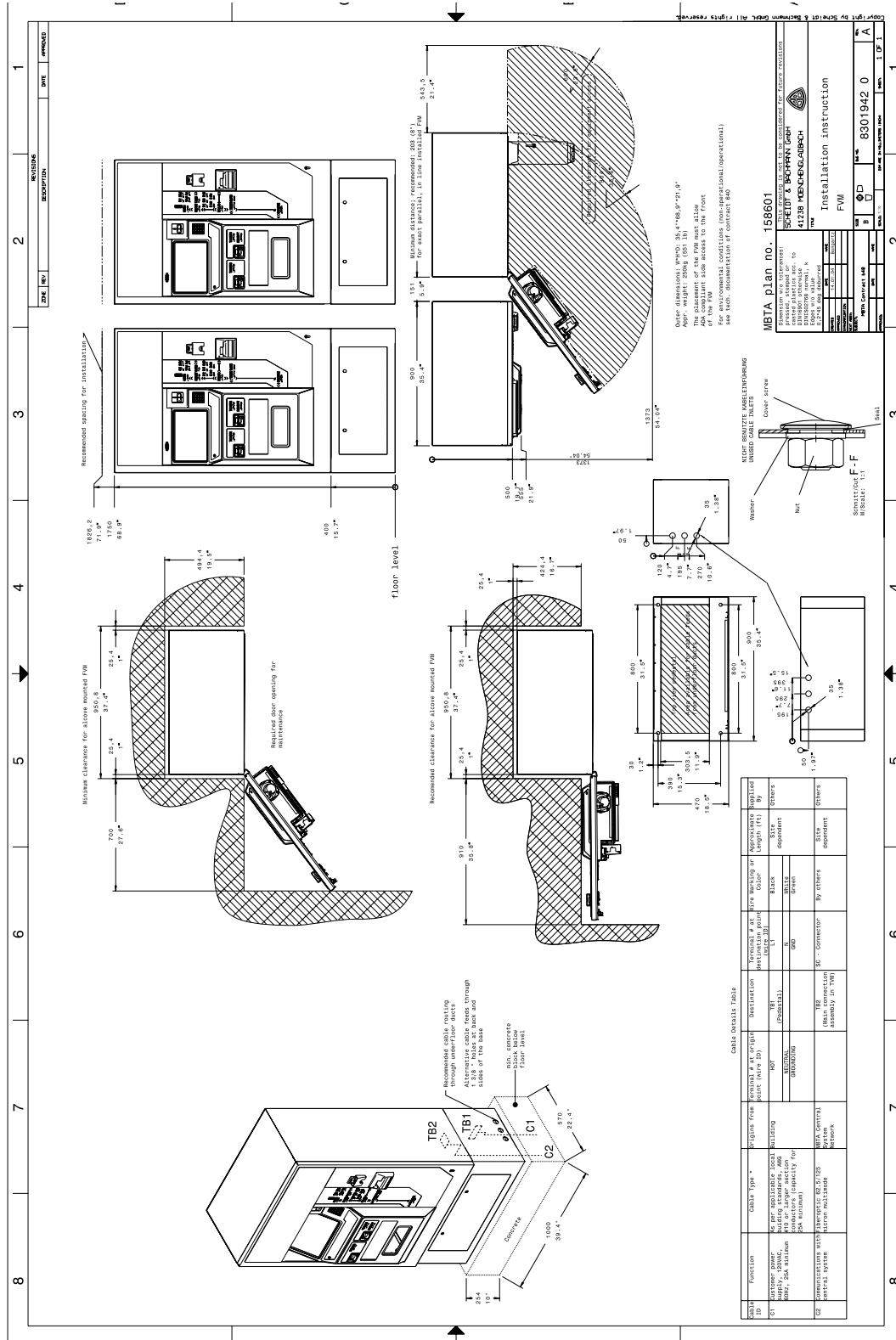


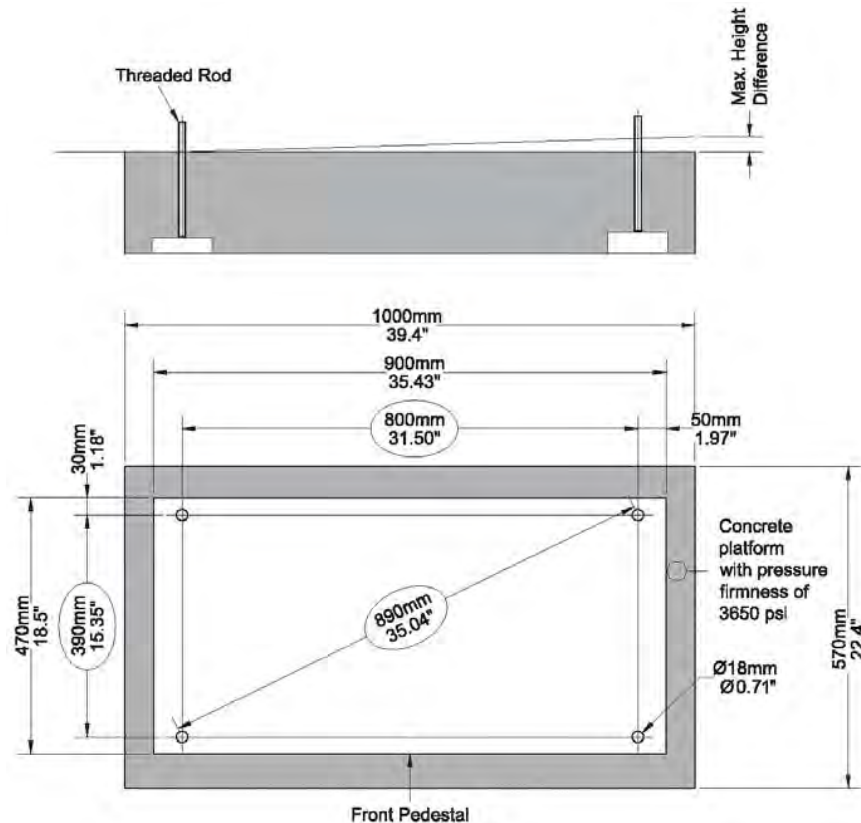
Figure 11-3 CCFVM Installation Clearances (for example only)

11.5 Site Preparation

Before installing the CCFVMs, the installer should prepare the designated location with a concrete platform having a recommended depth of 10" (**Figure 11-4** and **Figure 11-5**). Conduits and pull through cables must be in place before pouring concrete.

Existing cabling should be checked beforehand for completeness and functionality.

The concrete platform with the recommended dimensions (length 39.4 in. and width 22.4 in.) must be in place and must have a pressure firmness of 25 N/mm² (3650 PSI) (**Figure 11-4**).



(The three dimensions in circles are the distances between the bolts.)

Figure 11-4 CCFVM Installation Site: Concrete platform and CCFVM footprint.

The concrete platform should not be more than 3% out of level, measured from bolt to bolt.



Alternatives to structural concrete may be used provided the dimensions and firmness of the solid platform are equal to or better than the 3650 psi specified by Scheidt & Bachmann. The bolts must be set in concrete.

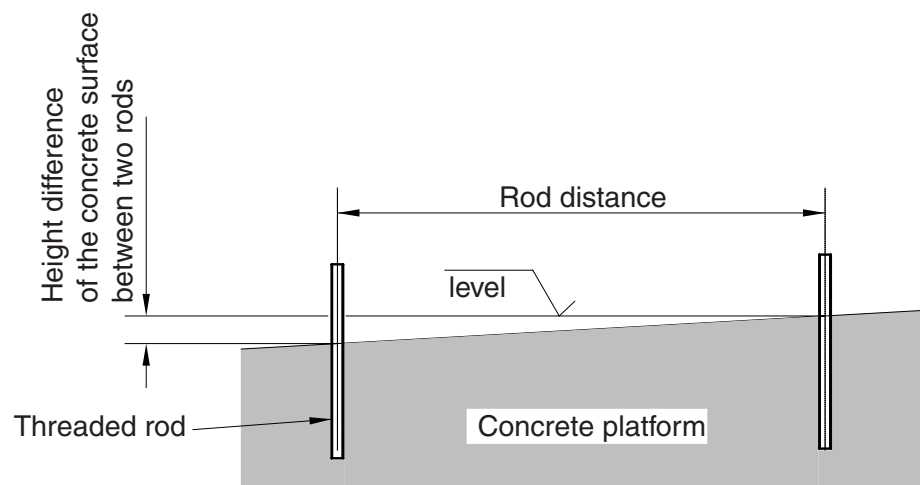


Figure 11-5 Maximum Permitted Height Difference of the Concrete Surface between Two Bolts



Ensure that there is no power on any cable before starting the installation. Breakers must be shut off and all data cabling should be disconnected.

Ensure that there are no cabling, gas lines, etc. near the proposed bolt location.



Protect bolt threads from damage by installers and the general public. Damaged bolts prevent CCFVM installation! This is especially important for those installations using the long bolt!

11.6 Transport Equipment

The CCFVMs must be transported to the Transit Authority work site and then to the prepared installation location by the safest possible means.

NOTE:

Destinations of equipment delivery are specified in CDRL 802.

11.6.1 Storage to Site

The installer must transport the CCFVMs to the Transit Authority work site by a safe, motorized means of transportation. Scheidt & Bachmann recommends enclosed trucks of sufficient size and weight bearing capability. The trucks should have motorized lift gates of sufficient capability to lift or lower one pallet containing one fully packaged CCFVM at a time. The CCFVM should be transported to the work site upright and in the original Scheidt & Bachmann packaging.



When loading and unloading CCFVMs, secure the load to prevent the CCFVMs, as mounted on the pallet, from tipping over! The combination of CCFVMs and pallet may become unsteady and tip! The CCFVM must be transported upright and not allowed to tip over! Do not drop or bang the CCFVM!

11.6.2 Site Transportation

As shipped by Scheidt & Bachmann, the CCFVMs will be mounted one to a pallet (skid). Scheidt & Bachmann recommends a pallet lifter similar to the WESCO Part # 272153, capacity 1,100 pounds. Scheidt & Bachmann recommends a machinery mover similar to the Rais-N-Rol 2000 pound capacity, Model # 260091, with binding accessories to secure the CCFVM while moving on sloped surfaces and stairs. These are examples. Similar or better tools may be used by the installer.



Use three or more people to transport and install each CCFVM!

CCFVMs should not be lifted with a crane!



The CCFVM must not be allowed to tip over! Once on site and removed from the original packaging, the CCFVM may be moved by a machinery mover. Care should be taken not to drop, bang, or damage the CCFVM in any way. It may be tilted, rotated, and manipulated in ways that allow the installer to move it to the installation location.

11.6.3 Unpacking

The CCFVMs should be unpacked with great care. When shipped from Scheidt & Bachmann, each CCFVM is bolted to two four by fours. The four by fours are then screwed to a pallet (skid). They are then wrapped in plastic and packaged in heavy-duty cardboard material. The cardboard is carefully secured to protect the CCFVM from damage. Finally, plastic straps with metal clips are used to secure the CCFVM to the pallet.



CCFVMs are typically shipped one to a pallet, each on its own four by fours and packaged individually!

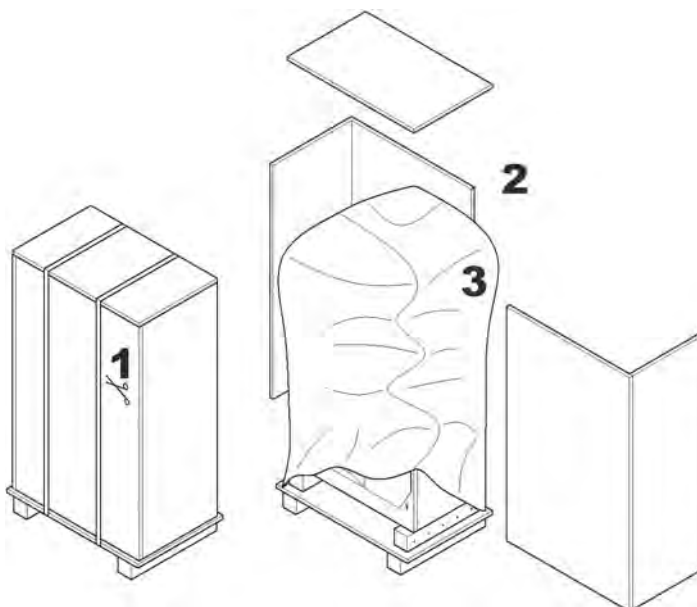


Figure 11-6 Unpacking the CCFVM

The CCFVMs should be unpacked in reverse order. First, the plastic straps with metal clips should be removed. Then, the cardboard packaging should be carefully removed. Then, the plastic wrapping should be removed. While the CCFVM is secure on the pallet (skid), it should be visually inspected for damage. Any damage should be noted and reported to Scheidt & Bachmann. Machines that pass the visual inspection are ready for installation.

- STEP 1:** Cut the plastic straps securing the CCFVM to the pallet (skid), **Figure 11-6, #1.**
- STEP 2:** Remove the cardboard outer packing, **Figure 11-6, #2.**
- STEP 3:** Remove the plastic wrapping material, **Figure 11-6, #3.**
- STEP 4:** Visually inspect the CCFVM for damage. If damaged, set the unit aside and notify Scheidt & Bachmann. If not, proceed with installation.
- STEP 5:** Dispose of packing material.

Transport the CCFVM, while still on the pallet (skid), to its installation location. Instructions for removing the CCFVM from the pallet (skid) are in section **11.10**. Leave the CCFVM on its shipping pallet (skid) until delivery to the exact installation location.



Keep the CCFVM securely attached to the pallet (skid) until it is delivered to the installation location at the installation site.

Disposal of all packing materials is the responsibility of the installer installing the CCFVM.

11.6.4 Pedestal Unpacking

Pedestals are packed either 6 or 8 to a pallet. They are wrapped in plastic “shrink wrap” and strapped to the pallet. The pedestals should be transported to the installation site, where they may be unpacked. First cut the plastic straps, then remove the plastic “shrink wrap” from the pedestals. Individual pedestals may be moved to their exact installation location by using a convertible hand truck in the platform truck mode. The Magliner Model CP585385 is an example. Of course, either the pallet lifter or machinery mover used for the CCFVM body may also be used for the pedestals.

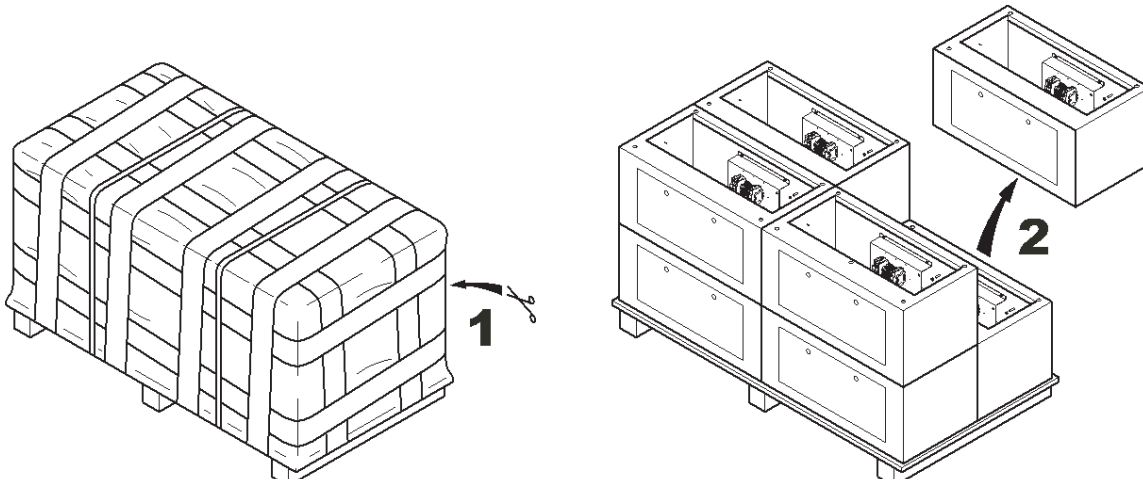


Figure 11-7 Pedestal Unpacking

11.7 Installation Requirements

The following special equipment, standard tools and preconditions are required for CCFVM installation.

11.7.1 Mounting and Drilling Tools and Materials

Below is a list of required tools and materials.

- Scheidt & Bachmann drilling template (See **Figure 11-8**)
- Hammer drill
- 14 mm drill
- 15 mm drill
- Blow-out Pump
- Four (4) Anchor Bolts
- Vacuum Cleaner
- Socket wrenches
- Open-end wrenches
- Bubble level
- Silicone caulk
- Two wooden four by fours minimum cross section: 3 x 3" minimum length 30"

11.7.2 Preconditions for CCFVM Installation

The following preconditions must be met by the installer before installing the Cash & Card Fare Vending Machine (CCFVM).

The installer must check the following items:

- ☒ Is there enough space available for the CCFVM housing and clearances (see **Figure 11-3**)?
- ☒ Are the Site Placement Considerations met (see **11.4**)?
- ☒ Is a 120V power cable available at the equipment location?
- ☒ Are all power and communications cables to the CCFVM terminated and labeled in accordance with station drawings?
- ☒ Is the communication cabling present and working? Use appropriate test devices to test continuity. Use a computer device to test TCP/IP Ping from end-to-end and from the location of the test device to the Central Computer System location.
- ☒ Are the required electricians available? Verify both the licenses and permits of the electricians for validity.
- ☒ Are the CCFVM body and pedestal and installation components available?



- ☒ Is a regular metric tool set available? A 174 piece SAE/Metric tool set with 4 drive tools, 10 wrenches, and 121 additional tools, similar to the Alltrade 320329 Tool Set with Tool Box, and a permanent marker (or color spray) and bubble level, should provide all the necessary tools to make any adjustments, connections, or installations required.
- ☒ Are a pencil and pad of paper available for note taking, such as noting IP addresses, and check list verification?
- ☒ Are a hammer drill, 14 mm drill, 15 mm drill and other drills as needed for anchors available?
- ☒ Are cable binders available? Panduit cable binders in these sizes are most useful: 3 7/8 inches by .098 inches (99 mm by 2.5 mm), 8 inches by .098 inches (203 mm by 2.5 mm), and 5 5/8 inches by .142 inches (142 mm by 3.6 mm).
- ☒ Verify with Network Control that the device is configured in the Central Computer System database and the software is available for download.
- ☒ Verify that the PIN Pads have necessary keys installed by the supplier of the equipment.
- ☒ Verify that all consumables are available. These include test tickets and receipt paper.
- ☒ Shut down the circuit breaker at the breaker panel so that no wires are “live” during installation. Use a voltmeter to verify power is off.
- ☒ For power wires, low voltage cables, and communication lines, use appropriate test devices.
- ☒ Are all required revenue components available?
- ☒ Are all required system keys available?
- ☒ Does the installer have access to all electrical and communication areas to ensure proper setup and installation?
- ☒ Are all doorways and other openings of sufficient size to ensure a proper transportation path from the curb side drop-off point to the final installation location?
- ☒ Are all the parts provided by other sources available?

11.8 Installation Procedures for the CCFVM

The following standard installation procedures should be used by the installer installing the CCFVMs.

11.8.1 Preparation of the mounting location

The installer must prepare the mounting location as instructed below.

- STEP 1:** Check the location (see 11.4).
- STEP 2:** Verify that all materials are available. “See “Mounting and Drilling Tools and Materials” on page 444.”.
- STEP 3:** Verify that all necessary tools are available. “See “Transport Equipment” on page 441.”.
- STEP 4:** Verify that all installation tools are available.
- STEP 5:** Remove all loose particles from the concrete platform and clean it thoroughly.
- STEP 6:** Use a bubble level to ensure that the concrete platform is level.
- STEP 7:** Place the template onto the designated concrete platform and align the template carefully.

DRILLPLAN PEDESTAL

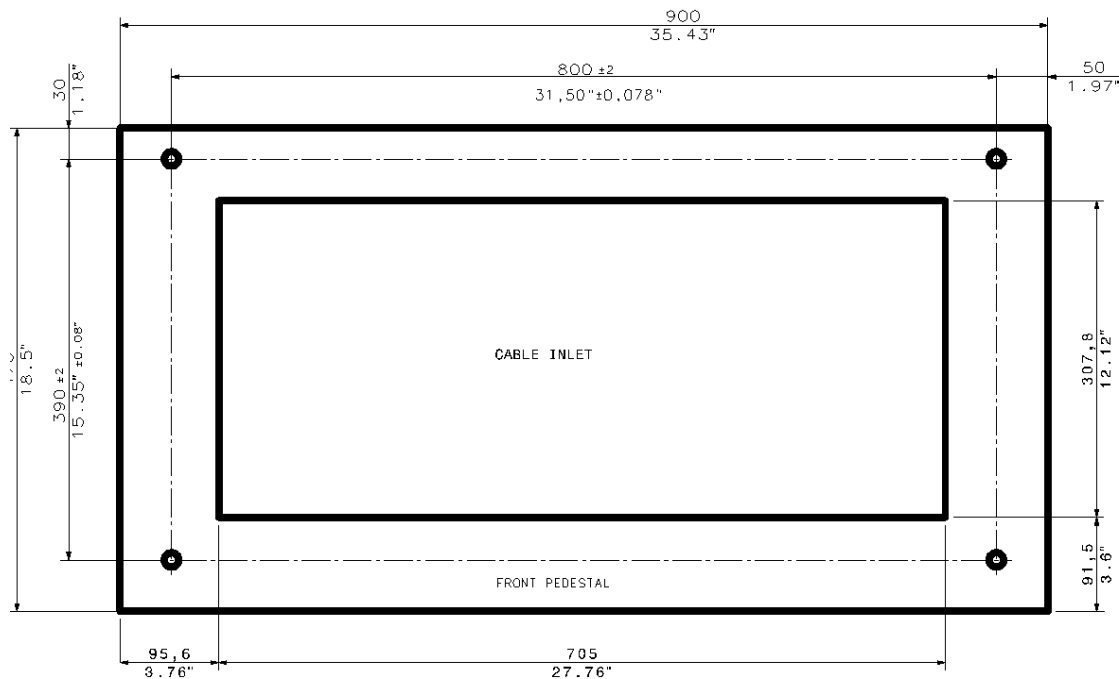


Figure 11-8 Drilling Template

- STEP 8:** Ensure that no cables, conduits, or gas lines are anywhere near the drill holes.

- STEP 9:** Ensure that openings in the concrete for conduits align with the breakouts in the CCFVM, so that cables will pass through with sufficient clearance.
- STEP 10:** Mark the locations of the drill holes with a permanent marker or color spray.
- STEP 11:** Remove the template from the designated site.
- STEP 12:** Drill four holes for the anchors or threaded rods using a hammer drill with a 14 mm bit for the UPAT anchors or a 15 mm bit for the expansion anchors. Drill four holes 140 mm (5.5") deep for the chemical anchors or 45 mm (1.77") deep for the expansion anchors. Be extremely careful. If the drill sticks, it can twist in your hands and cause serious injury.
- STEP 13:** Vacuum or blow out all drill holes.



Be extremely careful. If the drill sticks, it can twist in your hands and cause serious injury.

- STEP 14:** Clean the concrete platform thoroughly and ensure that all loose particles are removed.

11.8.2 Anchoring System Specifications

Both the chemical anchors and the expansion anchors are installed as described in this section.

- STEP 1:** Check the condition of the chemical anchor capsules. The anchors are usable if the glass capsule has not been damaged and the contents still flow with a honey-like consistency.
- STEP 2:** Insert either the UPAT chemical anchor capsules or the expansion anchor into the thoroughly cleaned drill holes.
- STEP 3:** Connect the UPAT anchor to the hammer drill. Using the percussion/rotary action of the drill (at the full load maximum speed of 250-500 revolutions per minute), carefully drive the anchor into the drill hole, using as much pressure as needed, until reaching the marked line (140 mm (5.52 inches) on the UPAT anchor and 45 mm (1.77") deep for the expansion anchors. Immediately stop drilling! A rotary drill must be used with this procedure because it mixes the capsule contents thoroughly, providing a fully mixed, pore free mortar. Check the thread on the bolt. If there is any damage, insert a new bolt.
- STEP 4:** Excessive force or time spent drilling in the anchor will empty the hole of mortar and result in inadequate bonding. Efforts to set the anchor in the mortar without a hammer drill, for example, with a hammer, will result in poor forming and curing of the mortar, leading also to inadequate bonding.
- STEP 5:** Once the chemical anchors are installed, let the synthetic resin mortar cure for the designated time shown in **Table 11-5**. Use a socket wrench to tighten the nut. When tightening the nut, do not exceed the recommended torque.



Alternatives to structural concrete may be used provided the dimensions and firmness of the solid platform are equal to or better than the 3650 psi specified by Scheidt & Bachmann. The bolts must be set in concrete.



Both anchoring systems have been used in the past, successfully. Our installation recommendations apply to typical installations. For non-typical structures, it is an engineering decision by the Station Architect which anchor or fastener is to be used. The two typical solutions presented herein represent the minimum standards and specification. The Transit Authority engineers may determine that some installations need something more, because of the unique situation found at that location. However, in any case the device is mounted on four 1/2 bolts.

Curing Times			
Temperature in Drill Hole		Waiting Time	
Degrees C	Degrees F	Minutes	Hours
over 20	over 68	20	
10 to 20	50 to 68	30	
0 to 10	32 to 50		1
-5 to 0	23 to 32		5

Table 11-5 Curing Times

The setting times shown in the table are for dry base material. Double the setting times in case of wet base material.

11.9 CCFVM Pedestal Installation Procedure

There are two installation procedures, one for long bolts and another for short bolts. Most CCFVMs and pedestals will be installed using long bolts. CCFVMs installed in alcoves will use the short bolts.

11.9.1 Long Bolt Pedestal Installation

The installer must follow the steps below when using long bolts for Pedestal and CCFVM installation. Long bolts are the default.

- STEP 1:** Check the location (See “Site Preparation” on page 439.)
- STEP 2:** Check the CCFVM Pedestal and CCFVM materials (compare to materials list) to ensure all materials have been supplied.
- STEP 3:** Unpack the CCFVM Pedestal.
- STEP 4:** Set the Pedestal in position before the long bolts have completely “set” in position. Lower the pedestal until the top of each bolt has passed through the corresponding hole on the bottom of the Pedestal. Before lowering the Pedestal completely to the concrete pad, place a washer, a nut, another nut, and a washer on each long bolt. The bottom washer and nut will secure the pedestal to the long bolts. The top washer and nut will help secure the Pedestal to the CCFVM body.

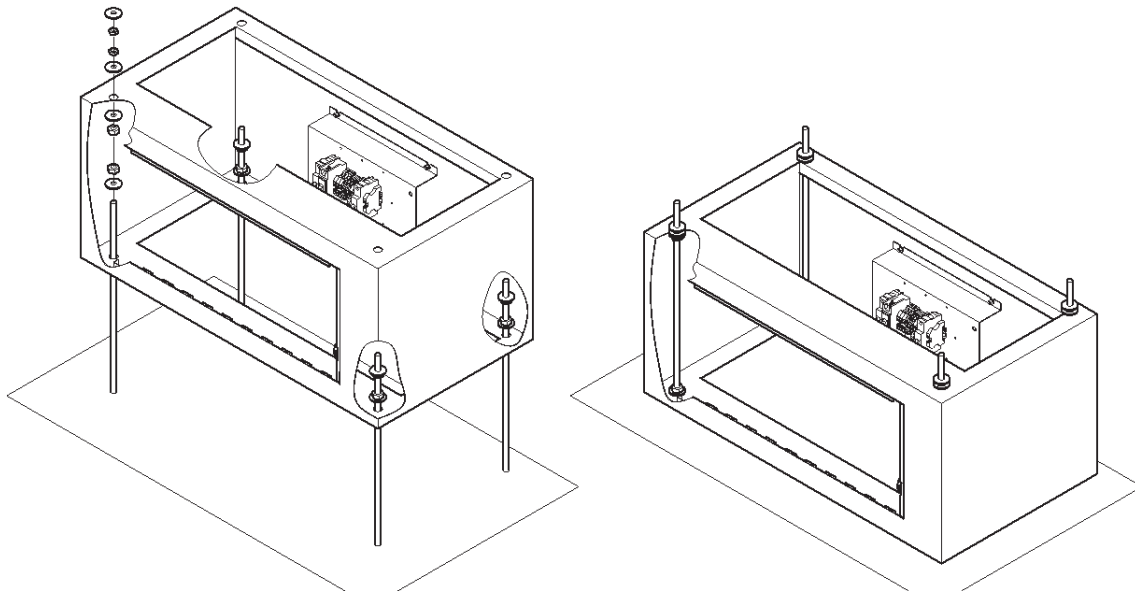


Figure 11-9 Long Bolt Pedestal Installation

- STEP 5:** Lower the Pedestal completely. Ensure the long bolts pass through the center of each hole in the Pedestal top.
- STEP 6:** Use a bubble level to ensure the CCFVM pedestal is level. If necessary, washers may be used to level the Pedestal. Install the washers on the appropriate bolt. If a stack of washers more than 1/2" thick is required, use cement to level the Pedestal as shown in **Figure 11-10**.



Long bolt installation locations should be as level as possible so the procedure outlined in Steps 6 and 7 need not be followed. When it is necessary to do so, work quickly and efficiently. The installation process should not interfere with the anchor bolt curing process!

- STEP 7:** Seal the gap between the Pedestal and the platform with silicone caulk.

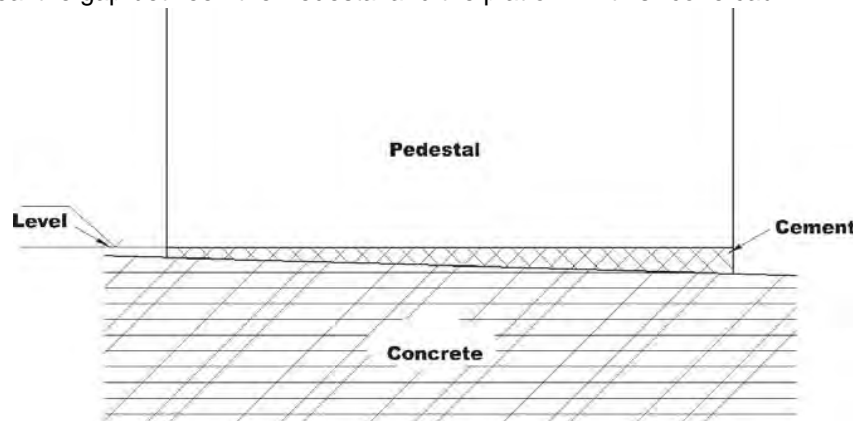


Figure 11-10 CCFVM Pedestal Leveling

11.9.2 Short Bolt installation

The installer must follow the steps below when using short bolts for CCFVM and Pedestal installation. Scheidt & Bachmann recommends using the short bolts for CCFVM installation in an alcove.

- STEP 1:** Check the location (See “Site Preparation” on page 439.).
- STEP 2:** Check the CCFVM Pedestal and CCFVM materials (compare to materials list) to ensure all materials have been supplied.
- STEP 3:** Clean the concrete platform thoroughly and ensure all loose particles have been removed.
- STEP 4:** Unpack the CCFVM Pedestal.
- STEP 5:** Place washer and nuts on each anchor bolt as shown in **Figure 11-11 Pedestal Mounting**. Tighten to 170 Nm, or as specified by the anchor manufacturer.

NOTE:

Scheidt & Bachmann recommends that the cable entry be located only underneath the CCFVM Pedestal. If the cable is located elsewhere, Scheidt & Bachmann will not take any responsibility for the consequences. The consequences of locating the cables somewhere other than underneath the CCFVM Pedestal can be (but are not limited to):

- Cables can be cut
- Wires can be melted

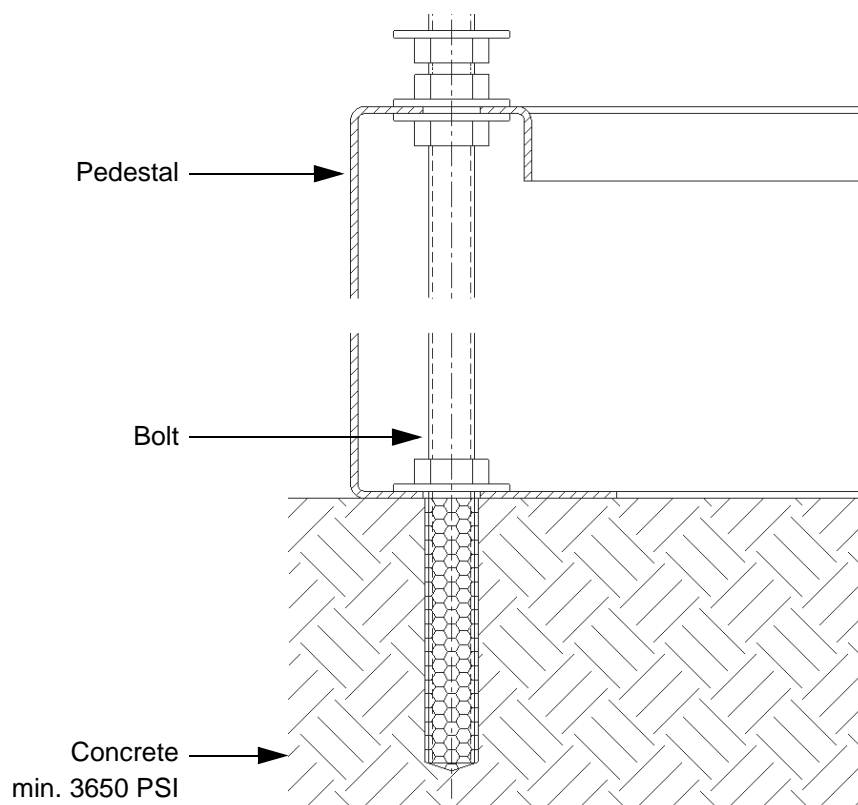


Figure 11-11 Pedestal Mounting

STEP 6: Use a bubble level to ensure the CCFVM pedestal is level. If necessary, use washers to level the pedestal. If a stack of washers more than 1/2" thick is required, use cement to level the pedestal as shown in **Figure 11-10** above.

STEP 7: Seal the gap between the pedestal and the platform with silicone caulk. Please see **Figure 11-10** above.

11.9.3 CCFVM Pedestal Main Power Installation

The following steps are common to both long and short bolt installation procedures and must be followed.



Ensure power to all cables is shut off before starting the installation. Breakers must be shut off and all data cables should be disconnected.

NOTE:

The installer sets-up equipment and pulls the cable into the pedestal. S&B connects the cables and tests the machine.

STEP 8: An authorized electrical worker should connect the power cable as shown in **Figure 11-12** and also **Figure 11-21**. See also **Table 11-6**.

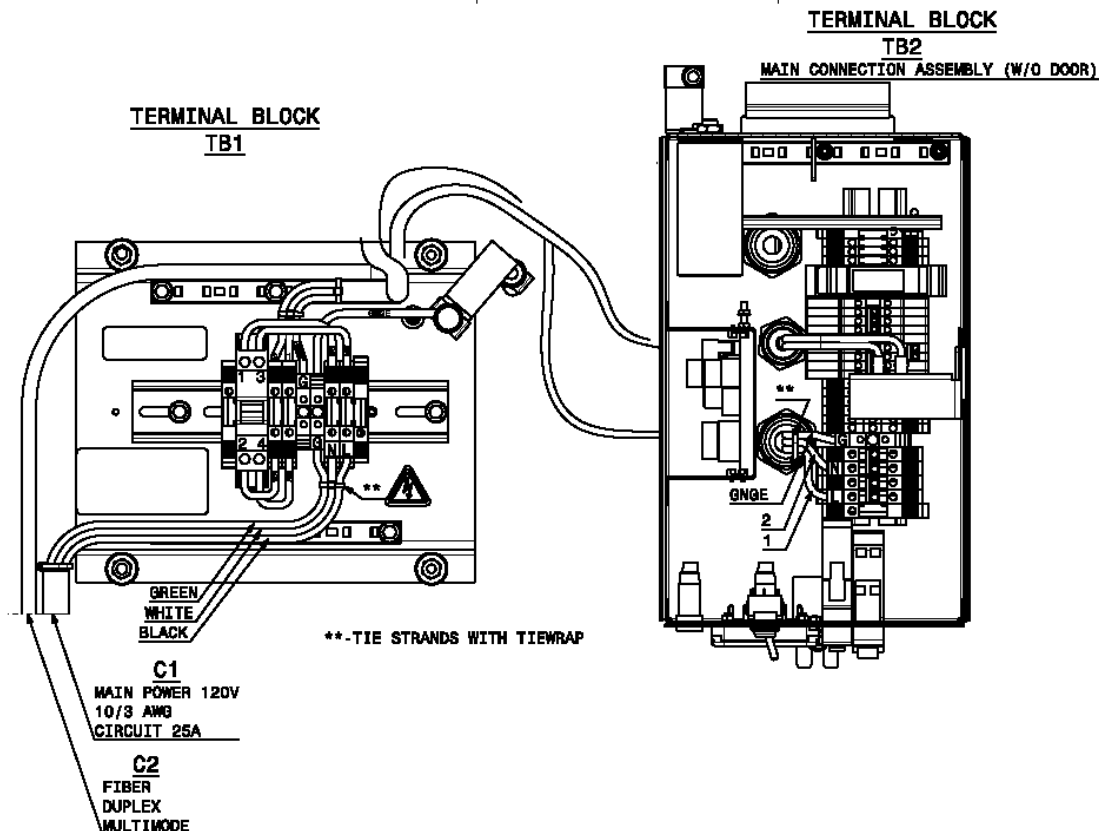


Figure 11-12 Power Connection Diagram

Cable ID	C1	C2
Function	Customer power supply, 120 VAC, 60Hz, 25A min	Communications with central system
Cable Type	As per applicable local building standards, AWG #10 or larger section conductors (capacity for 25A minimum)	Fiberoptic Duplex Multi Mode
Origin	Building	MBTA Central System Network
Destination	Terminal Block 1 (Pedestal) (TB1)	Terminal block 2 (Main connection assembly in TVM) (TB2)
Terminal # at destination point (wire ID)	L1, N, GND	SC - Connector
Wire Marking or Color	Black (L1), White (N), Green (GND)	By others
Approximate Length (ft)	Site Dependent (see position of terminal block)	Site dependent (see position of terminal block)
Supplied By	Others	Others

Table 11-6 Main Power and Network Cable Details (Provided by Others)

11.10 Mounting the CCFVM

Transport the CCFVM, using a pallet lifter or similar device, to its exact installation location. Refer to “**Installation Procedures for the CCFVM**” on **page 446**”. Remove the screws attaching the four by fours to the pallet (skid) and, using the pallet lifter, remove the CCFVM, while still attached to the four by fours, from the skid (**Figure 11-13**). Place the CCFVM down next to the Pedestal.

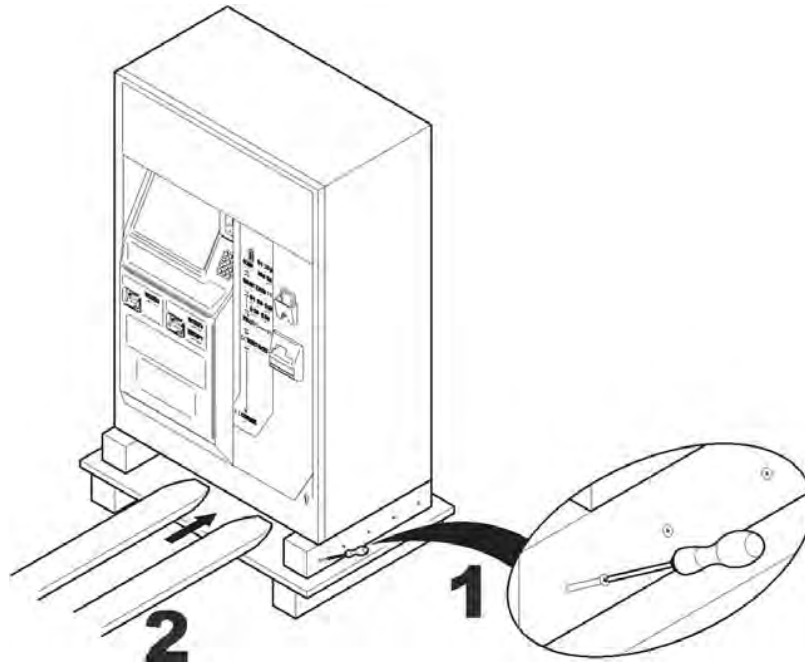


Figure 11-13 CCFVM Removal

11.10.1 Long Bolt CCFVM Installation

The following steps describe how to mount the CCFVM onto the CCFVM Pedestal when long bolts have been used to install the Pedestal.

- STEP 1:** Use a pallet lifter to lift the CCFVM off the pallet (skid).
- STEP 2:** Carefully open the CCFVM door with the Crank Key.



THE POSITION OF THE CENTER OF GRAVITY IS DEPENDENT ON THE DESIGN OF THE CCFVM AND CAN BE OFF-CENTER. TO AVOID TIPPING THE CCFVM, ONE PERSON MUST HOLD THE CCFVM DOOR. ANOTHER PERSON SHOULD HELP STEADY THE CCFVM.

- STEP 3:** Use a 17mm open-end wrench to loosen the nuts from the four by fours.
- STEP 4:** Remove the four nuts, the four washers, and the four bolts that secured the four by fours to the CCFVM.
- STEP 5:** Carefully close the CCFVM door using the Crank Key. Remove the two four by fours.
- STEP 6:** Place the four by fours on the Pedestal as shown in **Figure 11-14**.

STEP 7: Add one set of nuts and washers to each bolt on top of the CCFVM pedestal.

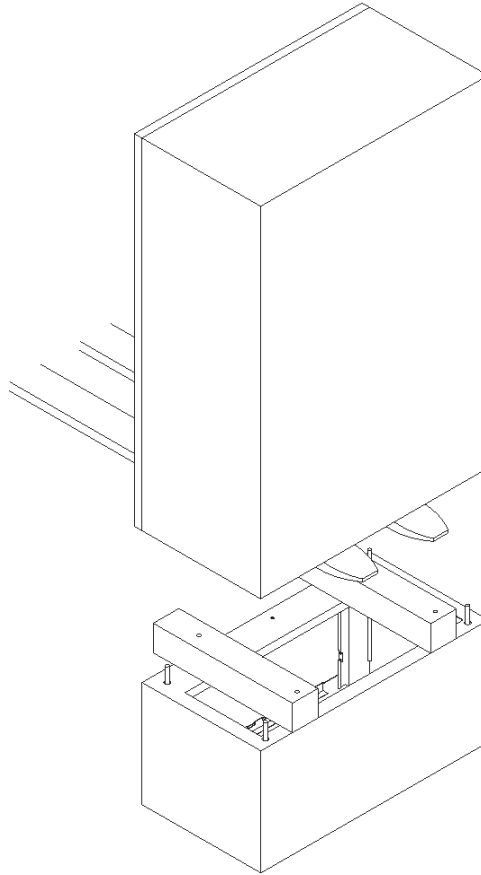


Figure 11-14 Long Bolt Installation

STEP 8: Use the pallet lifter to transport the CCFVM to the Pedestal. Position the CCFVM as close to the top of the Pedestal and four by fours as possible (**Figure 11-14**).

STEP 9: Carefully lower the CCFVM onto the four by fours. Three people must be present. If the CCFVM is not centered over the four by fours, the three people must maneuver it into position. Remove the pallet lifter.



THREE (3) PEOPLE ARE NECESSARY TO PLACE THE CCFVM ON THE PEDESTAL.

STEP 10: Align the four holes in the bottom of the CCFVM to the four bolts in the top of the pedestal.



THE POSITION OF THE CENTER OF GRAVITY IS DEPENDENT ON THE DESIGN OF THE CCFVM AND CAN BE OFF-CENTER. TO AVOID TIPPING THE CCFVM, ONE PERSON MUST HOLD THE CCFVM DOOR. ANOTHER PERSON SHOULD HELP STEADY THE CCFVM.

- STEP 11:** Carefully push the left hand side of the CCFVM up until the left four by four is removable. The person on the opposite side of the four by four always provides resistance. This prevents the CCFVM from sliding from the base.
- STEP 12:** The person in front of the CCFVM removes the left four by four.
- STEP 13:** Carefully lower the CCFVM until the anchor bolts pass through the two holes and the CCFVM touches the Pedestal (**Figure 11-15**).

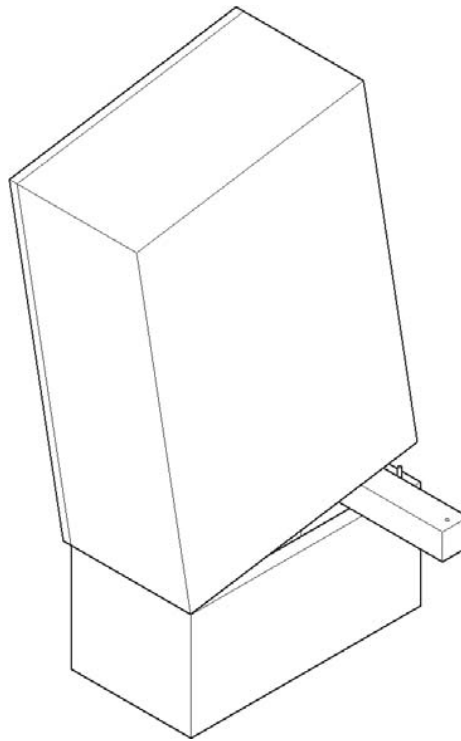


Figure 11-15 CCFVM Installation Technique

- STEP 14:** Carefully push the right hand side of the CCFVM up until the right four by four is removable. The person on the opposite side of the four by four provides resistance.
- STEP 15:** The person in front of the CCFVM removes the right four by four.
- STEP 16:** Carefully lower the CCFVM until the anchor bolts pass through the two holes and the CCFVM sits on the Pedestal.



Carefully open the CCFVM door with the crank key.
The CCFVM is top-heavy! To prevent the CCFVM from tipping over, one person must hold the CCFVM door.

- STEP 17:** Place a 12 mm nut with a washer on each bolt. Tighten each nut loosely with a 19 mm open-end wrench.

- STEP 18:** Check the level of the CCFVM body: width and depth. If the machine is not level, use nut number 7 (**Figure 11-18**) in the appropriate corner to raise or lower the CCFVM body. There should be no visible gap between the body of the CCFVM and the base. This is a minor adjustment requiring no more than one turn of the nut.
- STEP 19:** Once the machine is level on the base, tighten the nuts and washers placed on the long bolts on the topside of the Pedestal as instructed in **STEP 7**.
- STEP 20:** Once the nuts and washers are tightened as instructed in **Step 19**, recheck the level in both width and depth. If the CCFVM body is not level, repeat **Step 18** and **Step 19** until the machine is level.

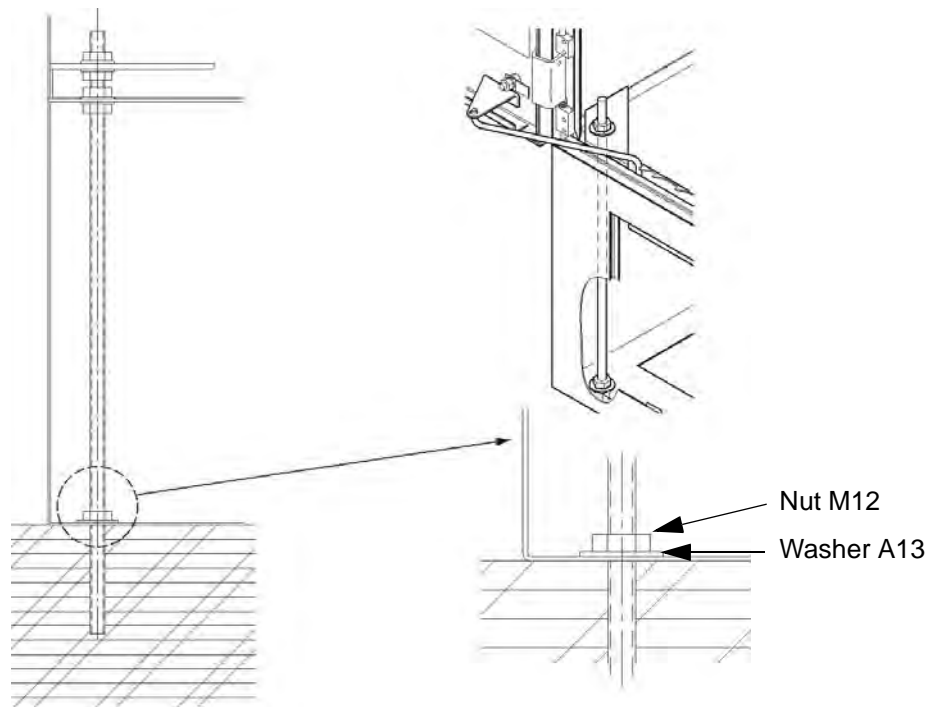
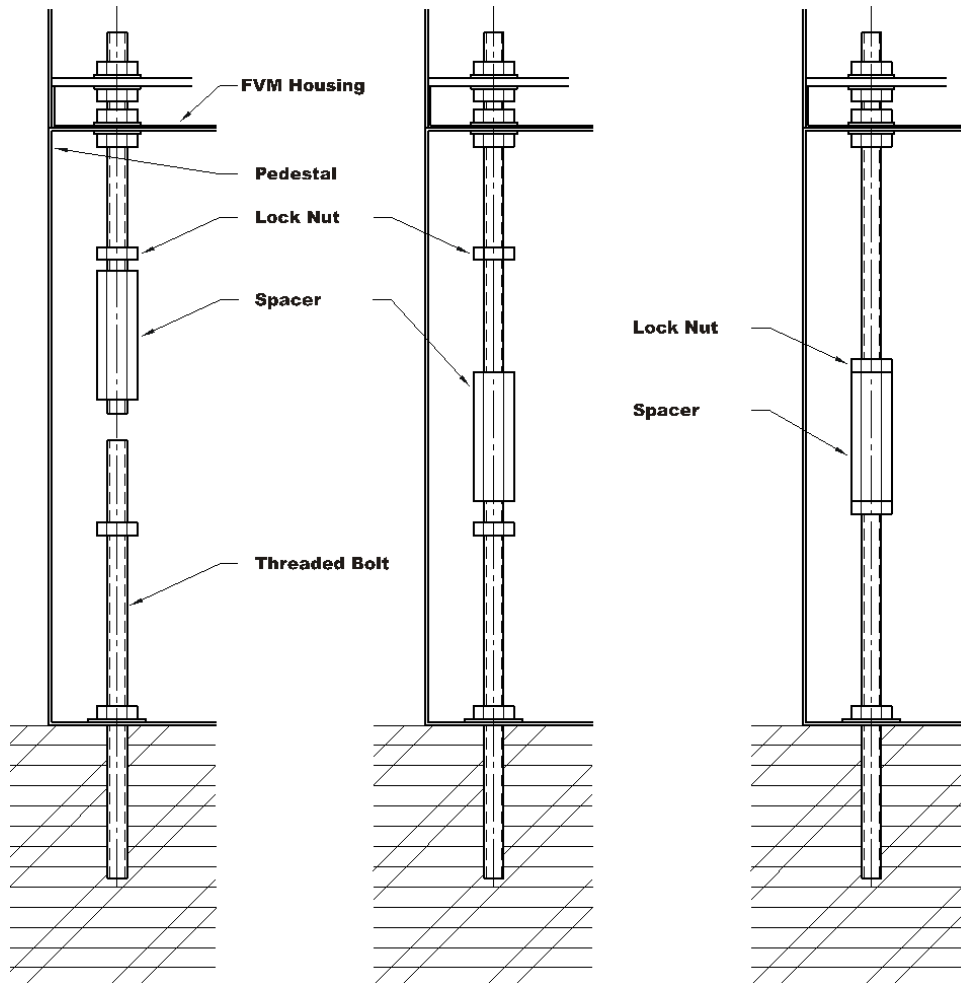


Figure 11-16 Fasten Pedestal

**Figure 11-17 Lock Nuts**

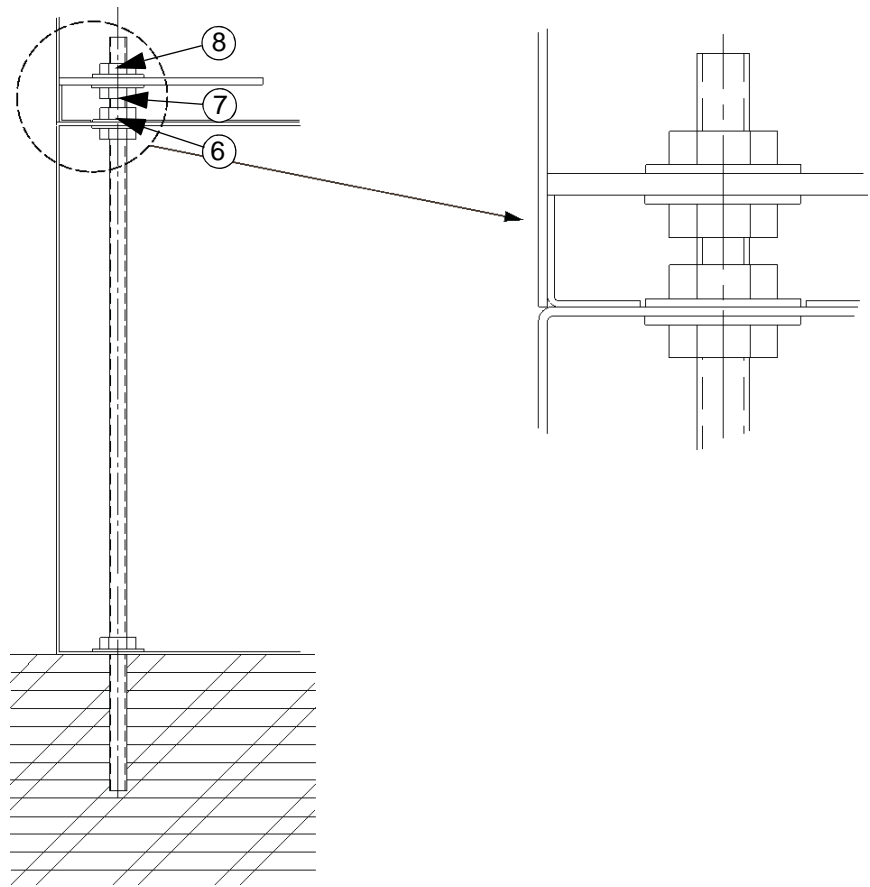


Figure 11-18 Adjust CCFVM

11.10.2 Short Bolt CCFVM Installation

The following steps describe how to mount the CCFVM onto the CCFVM Pedestal when short bolts have been used to install the Pedestal.

STEP 1: Carefully open the CCFVM door with the Crank Key.



THE POSITION OF THE CENTER OF GRAVITY IS DEPENDENT ON THE DESIGN OF THE CCFVM AND CAN BE OFF-CENTER. TO AVOID TIPPING OVER THE CCFVM, ONE PERSON MUST HOLD THE CCFVM DOOR TO PREVENT THE CCFVM FROM TIPPING OVER.

STEP 2: Use a 17mm open-end wrench to loosen the nuts from the four by fours.

STEP 3: Remove the four nuts, the four washers, and the four bolts that secured the four by fours to the CCFVM. Carefully close the CCFVM door using the Crank Key.

STEP 4: Use the pallet lifter to transport the CCFVM to the CCFVM Pedestal. Raise the CCFVM level with the top of the Pedestal.

STEP 5: Carefully slide the CCFVM onto the Pedestal.



THREE (3) PEOPLE ARE NECESSARY TO PLACE THE CCFVM ON THE PEDESTAL.

STEP 6: Align the four holes in the bottom of the CCFVM to the four holes in the top of the pedestal.



THE POSITION OF THE CENTER OF GRAVITY IS DEPENDENT ON THE DESIGN OF THE CCFVM AND CAN BE OFF-CENTER. TO AVOID TIPPING OVER THE CCFVM, ONE PERSON MUST HOLD THE CCFVM DOOR TO PREVENT THE CCFVM FROM TIPPING OVER.

STEP 7: Use the Crank Key to carefully open the CCFVM door.

STEP 8: Place a 12 mm bolt with a washer through each of the four mounting holes in the CCFVM Corner Pieces (**Figure 11-11**).

STEP 9: Place a 12 mm nut with a washer on each bolt (**Figure 11-11**).

STEP 10: Tighten each nut with a 19 open-end wrench, or ratchet.

STEP 11: An authorized worker should connect the power cable as shown in **Figure 11-19** and **Figure 11-21**.

STEP 12: An authorized communications worker should connect the communication cable as shown in **Figure 11-20** and **Figure 11-21**. This work should be coordinated with the Network Administrator and other networking management officials.

NOTE:

Use the network connection kit to connect the fiber cables: Fiber duplex Multimedia.



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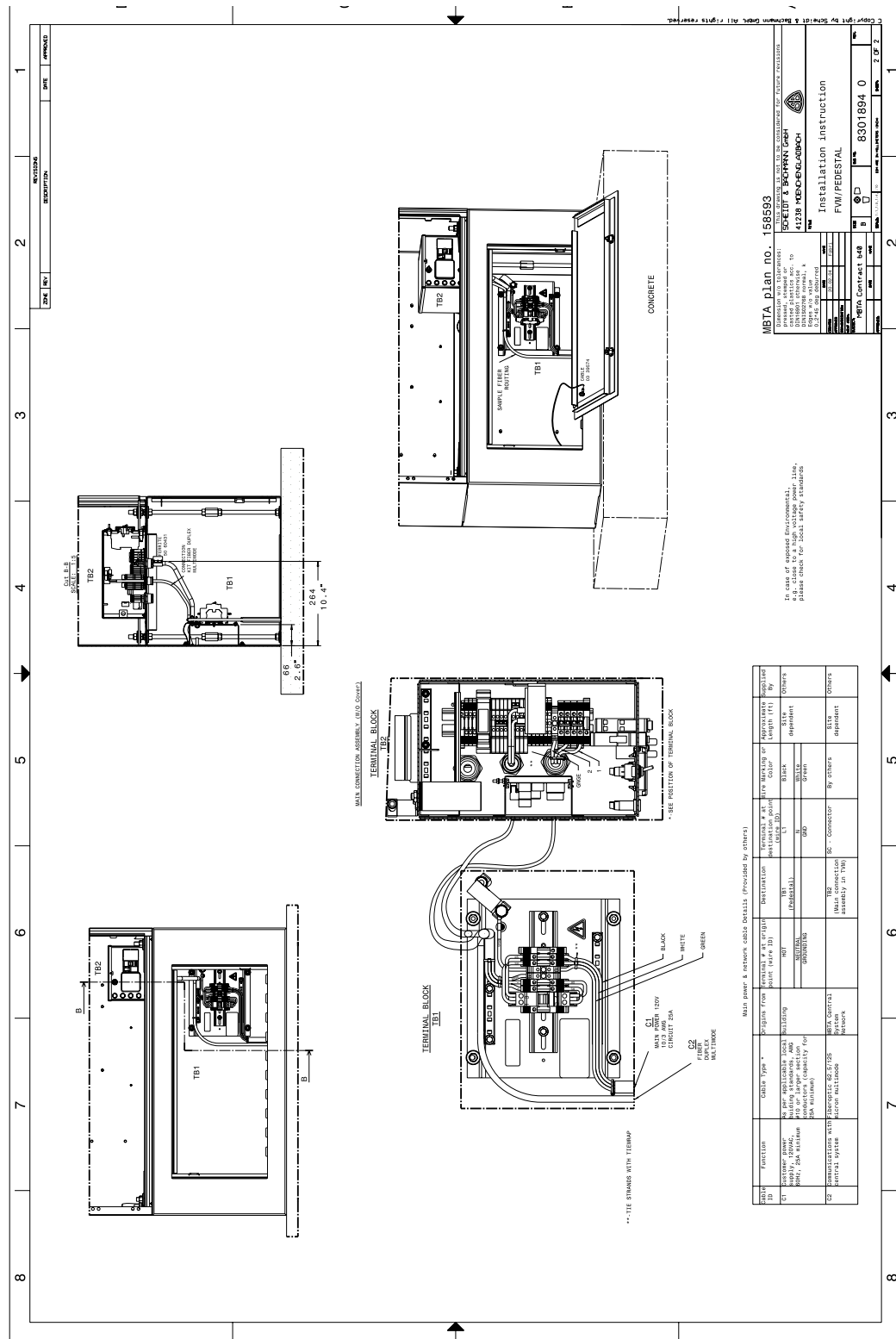


Figure 11-21 Pedestal Door Open

NOTE:**Use two keys to open the pedestal door lock!**

- Lift the cover of the power supply/main connection unit and take it out of the pedestal. It is attached to a ground lead, but not screwed or locked.
- Turn the cover upside down. Unscrew the nut for the ground lead with a 10 mm socket wrench. Remove the cover.
- Loosen the 4 nuts inside of the pedestal. Use a 17 mm open-end wrench. Remove the four nuts and the four washers (**Figure 11-21**).



Carefully open the CCFVM door with the crank key.

The CCFVM is top-heavy!

To prevent the CCFVM from tipping over, one person must hold the CCFVM door.

- Place a 12mm nut with a washer on each thread bolt. Tighten each nut with a 19 mm open-end wrench.
- Tighten the distance bolts on the bolts. Use a 19 mm open-end wrench. Tighten the lock nut.

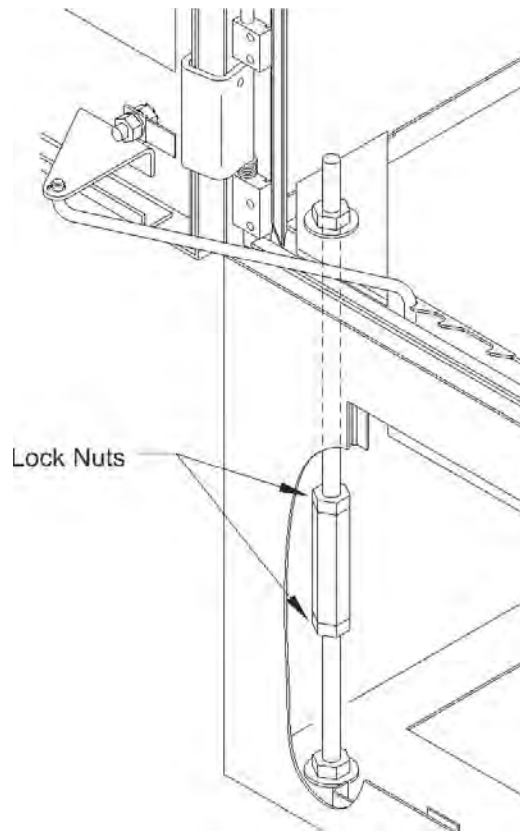


Figure 11-22 Lock Nut Location

- To ensure both that the CCFVM is level and the CCFVM door closes properly, use a 19 mm open-end wrench to adjust the leveling nuts between the CCFVM and pedestal.

- Referring to **Figure 11-23**, loosen nuts 6 and 8 to provide clearance in order to lift the respective CCFVM corner.
- Tighten nut 7 to lift the respective CCFVM corner.
- Tighten nuts 6 and 8 to fix the CCFVM corner tightly.

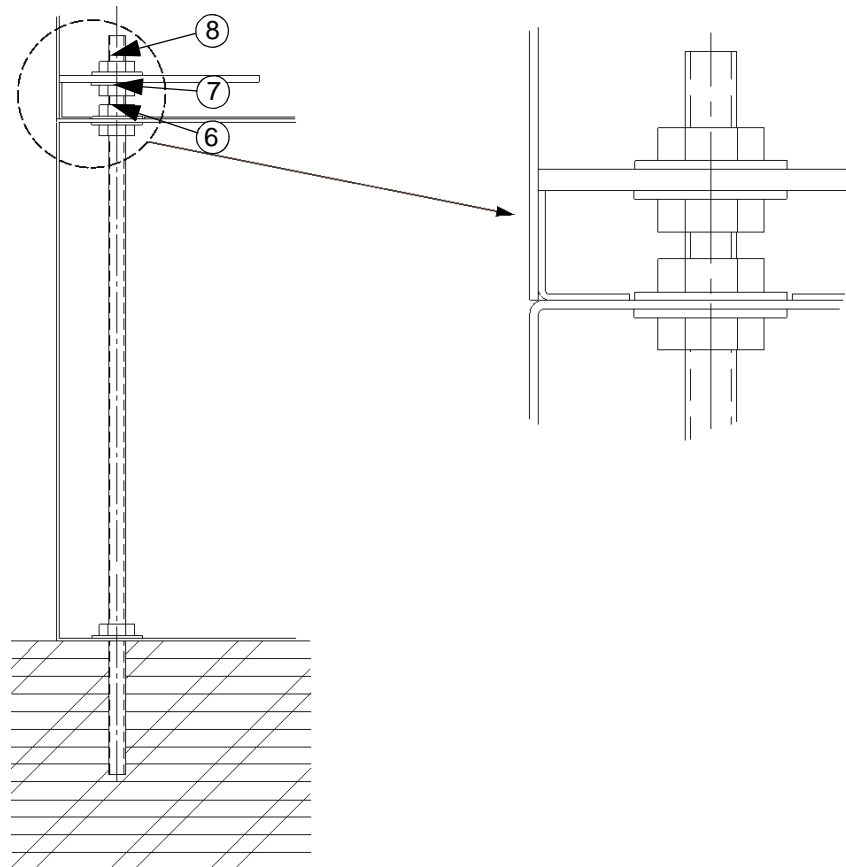


Figure 11-23 Adjust CCFVM



To get more working space, unscrew the M10 nut in front of the power connection box in order to move the box.

11.11 CCFVM Wiring

The installer will provide an electrician to pull cables into the CCFVM. Scheidt & Bachmann will provide an authorized employee to connect the power cables to the terminal block. An authorized Scheidt & Bachmann communications worker will connect the communications cable.

In the event of daisy-chaining, the installer's electrician will pull wires into the CCFVM and Pedestal as well as run wires through conduit to the next CCFVM Pedestal in line. Scheidt & Bachmann personnel will connect power and communications cables. The holes will be sealed upon shipment from Scheidt & Bachmann. The seals may be removed to feed cables from one CCFVM to another. The holes must be resealed once the cables are daisy-chained.

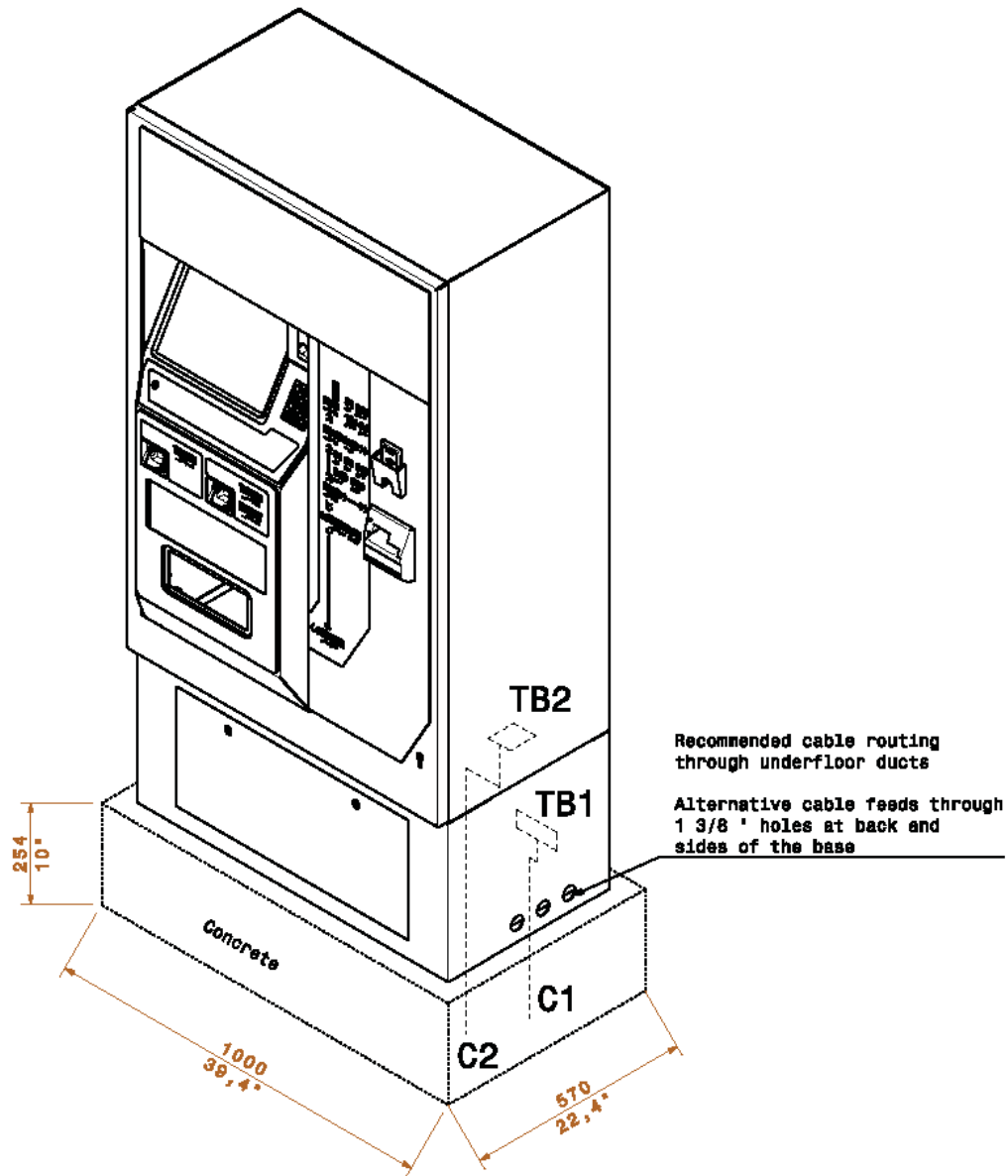


Figure 11-24 CCFVM Cable Routing Holes

Cable ID	Function	Cable Type *	Origins from	Terminal # at origin point (wire ID)	Destination	Terminal # at destination point (wire ID)	Wire Marking or Color	Approximate Length (ft)	Supplied By
C1	Customer power supply, 120VAC, 60Hz, 25A minimum	As per applicable local building standards, AWG #10 or larger section conductors (capacity for 25A minimum)	Building	HOT	TB1 (Pedestal)	L1	Black	Site dependent	Others
				NEUTRAL		N	White		
				GROUNDING		GND	Green		
C2	Communications with central system	Fiberoptic	MBTA Central System Network		TB2 (Main connection assembly in TVM)	SC - Connector	By others	Site dependent	Others

Table 11-7 Cable Details

11.12 Daisy Chaining

In the event CCFVMs are daisy-chained, they should be connected as described in **Figure 11-25** (refer to S&B 83 01915, MBTA 158600 full-size drawing for clarity).

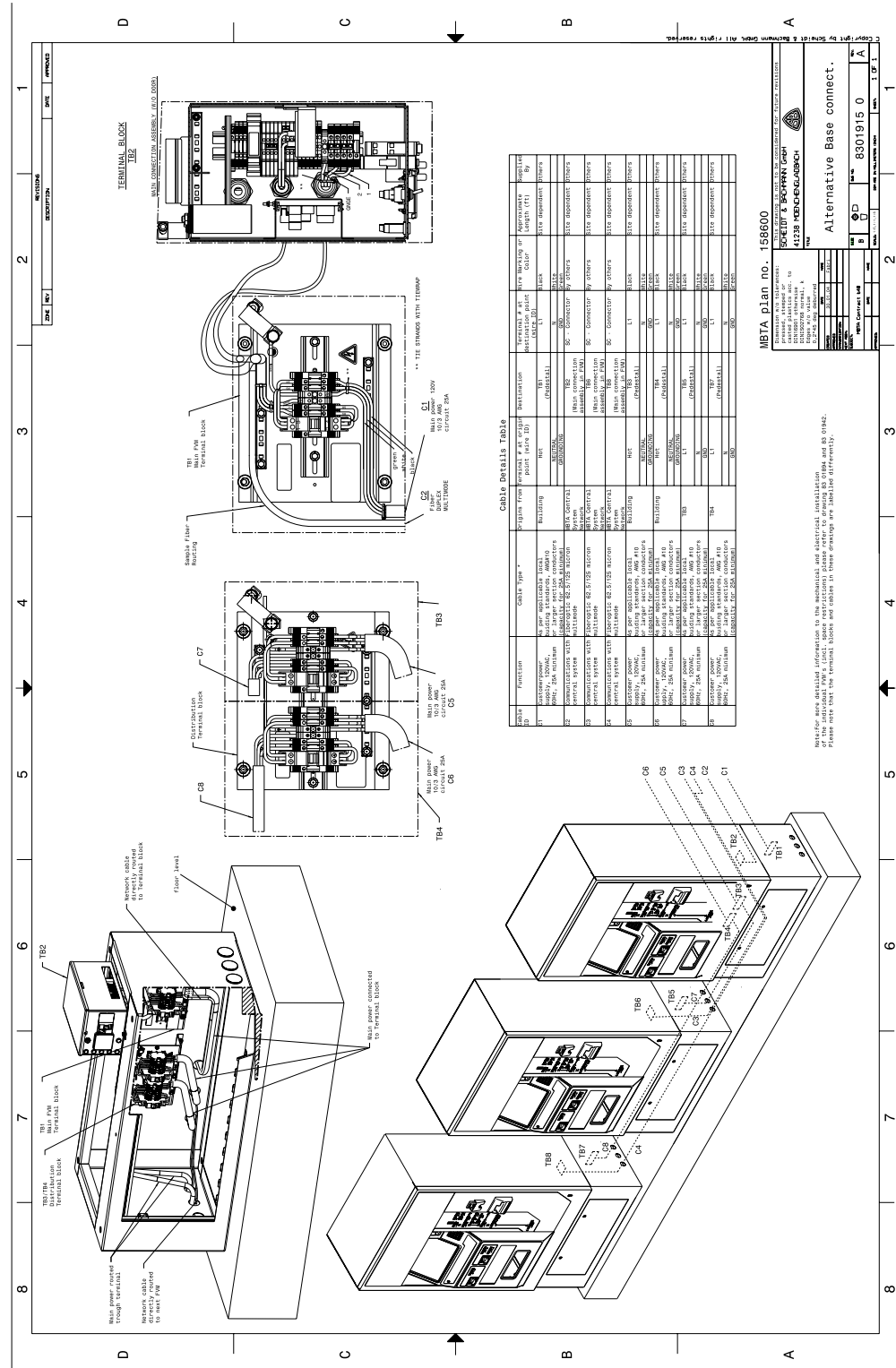


Figure 11-25 CCFVM Daisy Chaining

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Cable Details Table

Cable ID	Function	Cable Type *	Origins from	Terminal # at origin point (wire ID)	Destination	Terminal # at destination point (wire ID)	Wire Marking or Color	Approximate Length (ft)	Supplied By
C1	Customer power supply, 120VAC, 60Hz, 25A minimum	As per applicable local building standards, AWG #10 or larger section conductors (capacity for 25A minimum)	Building	Hot	TB1 (Pedestal)	L1	Black	Site dependent	Others
				NEUTRAL		N	White		
				GROUNDING		GND	Green		
C2	Communications with central system	Fiberoptic Duplex Multimode	MBTA Central System Network		TB2 (Main connection assembly in FVM)	SC - Connector	By others	Site dependent	Others
C3	Communications with central system	Fiberoptic Duplex Multimode	MBTA Central System Network		TB6 (Main connection assembly in FVM)	SC - Connector	By others	Site dependent	Others
C4	Communications with central system	Fiberoptic Duplex Multimode	MBTA Central System Network		TB8 (Main connection assembly in FVM)	SC - Connector	By others	Site dependent	Others
C5	Customer power supply, 120VAC, 60Hz, 25A minimum	As per applicable local building standards, AWG #10 or larger section conductors (capacity for 25A minimum)	Building	Hot	TB3 (Pedestal)	L1	Black	Site dependent	Others
				NEUTRAL		N	White		
				GROUNDING		GND	Green		
C6	Customer power supply, 120VAC, 60Hz, 25A minimum	As per applicable local building standards, AWG #10 or larger section conductors (capacity for 25A minimum)	Building	Hot	TB4 (Pedestal)	L1	Black	Site dependent	Others
				NEUTRAL		N	White		
				GROUNDING		GND	Green		
C7	Customer power supply, 120VAC, 60Hz, 25A minimum	As per applicable local building standards, AWG #10 or larger section conductors (capacity for 25A minimum)	TB3	L1	TB5 (Pedestal)	L1	Black	Site dependent	Others
				N		N	White		
				GND		GND	Green		
C8	Customer power supply, 120VAC, 60Hz, 25A minimum	As per applicable local building standards, AWG #10 or larger section conductors (capacity for 25A minimum)	TB4	L1	TB7 (Pedestal)	L1	Black	Site dependent	Others
				N		N	White		
				GND		GND	Green		

Table 11-8 Daisy Chaining Cable Details

11.13 Post-Installation Inspection

Once the installer has successfully installed the CCFVM, certain quality checks must be undertaken. At a minimum, check the following items:

- ☒ Grounding - an ohm meter reading checking the earth and neutral connections on the terminal block should read zero (**Figure 11-19**).
- ☒ Use a voltmeter or similar device to verify the 120V power supply is operational at 120 VAC \pm 10%.
- ☒ CCFVM level - use a bubble level for this check.
- ☒ Door swing - adjustments may be made by adjusting the bolts at the top and bottom of the door hinge (see **11.8**).
- ☒ Clearances for service and maintenance access. Please refer to **Figure 11-3 CCFVM Installation Clearances**.
- ☒ Ensure the stability of the CCFVM to prevent the tilt alarm from sounding under normal use.
- ☒ Ensure all cables are terminated and labeled correctly (see **Figure 11-21** and **Figure 11-25**).
- ☒ Ensure the communication cabling is working correctly. Use appropriate test devices to test continuity. Use a computer device to test TCP/IP Ping from end-to-end and from the location of the test device to the Central Computer System location.

When these checks are successfully completed, a S&B technician will power-on the CCFVM. The CCFVM should boot-up. If the basic software boots successfully, the CCFVM is ready for initialization. Proceed to Chapter 12 - Initialization.

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VOLUME 1 – Chapter 11
CCFVM Installation

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VOLUME 1 – Chapter 11 Installation

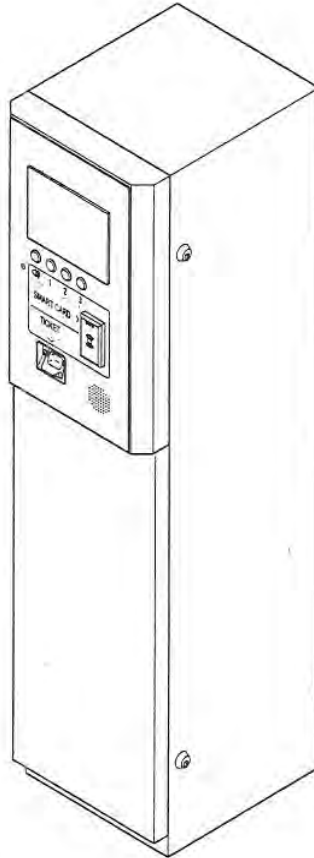


Figure 11-1 Fare Media Validator (FMV)

11.1 FMV Installation: General Description

The following information is provided for use by anyone undertaking the installation of a Fare Media Validator (FMV).

- When packaged for shipment, FMVs are secured to two transport four by fours.
- The two transport four by fours are secured to a shipping pallet (skid).
- The FMV must always be transported in the upright position.
- Use a pallet lifter for transport.
- Use a Machinery Mover for transport on stairs.
- To avoid damage, deliver FMVs to the installation location in the original Scheidt & Bachmann packaging.

The information listed above is introductory. Detailed descriptions and drawings may be found throughout this chapter. The following warnings should be heeded as well.





Three or more people should transport and install each FMV. Do not drop or bang the FMV!



NOTE: The FMV can tip over. Never allow the FMV to tip over. It must be kept upright and transported to its installation location upright.

Ensure that there is no power on any cable before starting installation. Main Circuit Breakers must be shut off and all data cabling should be disconnected.

An electrician installs power cables in the FMV.



An authorized Scheidt & Bachmann electrical worker will connect the power cables.

An authorized Scheidt & Bachmann communications worker will connect the communication cable.

11.2 Dimensions and Weight

FMV	FMV Unpacked	FMV packed
Height	60.63"	~ 67'
Width	14.96"	~ 19"
Depth	18.60"	~ 28"
Weight	~ 200 lbs.	~ 240 lbs

Table 11-1 FMV Dimensions and Weight

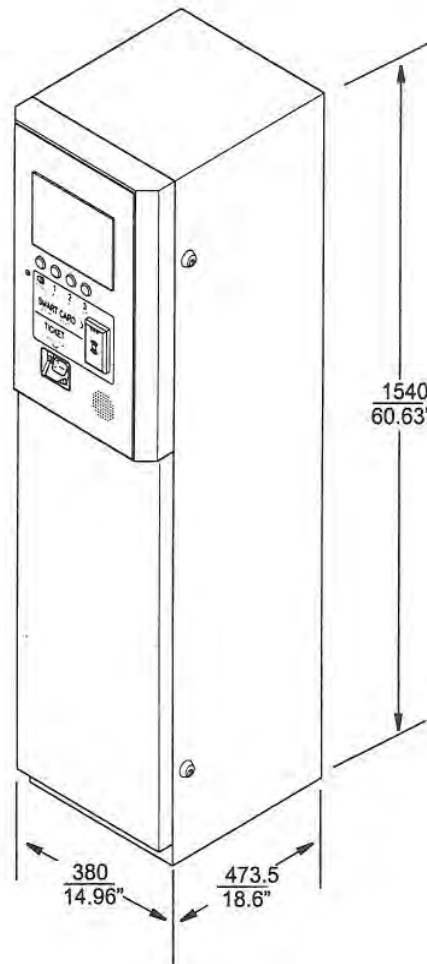


Figure 11-2 FMV Dimensions

11.3 Power Consumption

FMV power usage is listed below.

- The FMV is set for 6.3 amperes
- The Heater is set for 10 amperes
- The Service Outlet is also set for 5 amperes

FMV power consumption is 1,000 watts maximum excluding any power outlet usage. The power supply is 120 VAC. The power frequency is 60 Hz.

NOTE:

All branch circuits for hard wired units must be suitable for the unit ratings.



11.4 Site Placement

The design of the installation location is important. The MBTA, its architect, and installers are responsible for:

- Adhering to historic site preservation regulations.
- Ensuring clearance and access requirements are met.
- Taking weather into consideration when transporting and installing FMVs.
- Checking stairways for soundness and weight-bearing.
- Checking elevators for size, capacity, and weight-bearing capability.
- Ensuring the weight-bearing capability of the installation site floor.
- Ensuring the security of the installation site from preparation to completion of installation.

Scheidt & Bachmann understands there are federal and state historic site preservation regulations. Many of the communities in the MBTA region may have historic preservation committees that have a voice in any changes to historic buildings. The MBTA, its architect, and installers are responsible for these matters.



Ensure clearance and access requirements are met!

Ensure compliance with ADA requirements!

Consider weather when deciding the placement of FMVs!

Ensure stairways are of sound construction and meet weight-bearing requirements!

Ensure elevators have the necessary size, capacity, and weight-bearing capabilities!

Ensure the security of the installation site!

11.4.1 FMV Mounting Conditions

During transportation and when an FMV is installed but not operational, the environmental and storage conditions of **Table 11-2** must be met. The requirements for FMV mounting must also be met. Observing these requirements is the responsibility of the MBTA, its architect, and installers. Minimum clearances between FMVs, minimum distances from obstructions, placement in a convenient location for patrons but out of the flow of pedestrian traffic, and placement where temperature extremes, sunlight, and weather conditions do not hamper any patron's use of the machines, are all considerations that should be foremost in the minds of those planning, and actually performing, the installation.

Non-operational Environmental Condition	Acceptable Range
Temperature Range	20° F to 113° F (-6.7° C to 45° C)
Thermal Shock	1° F per minute drop in temperature over a 15° F range between 110° F and 60° F
Humidity	5% to 80 % non-condensing
Altitude	-200 ft to 40,000 ft

Table 11-2 Environmental Conditions

In particular, the Customer Interface, which is the primary means of communication with patrons, should be properly protected from rain, snow, freezing precipitation, and direct sunlight **Table 11-2** environmental conditions apply when the FMV is installed but not operational.



Rain, snow, and freezing precipitation will cause operational problems!

Placing a FMV in direct sunlight will hinder the patron's use of the screen!

Environmental and storage conditions must be observed!

When installing FMVs, the following clearances must be provided (refer to S&B 83 01902, MBTA 158596 full-size drawing for clarity).

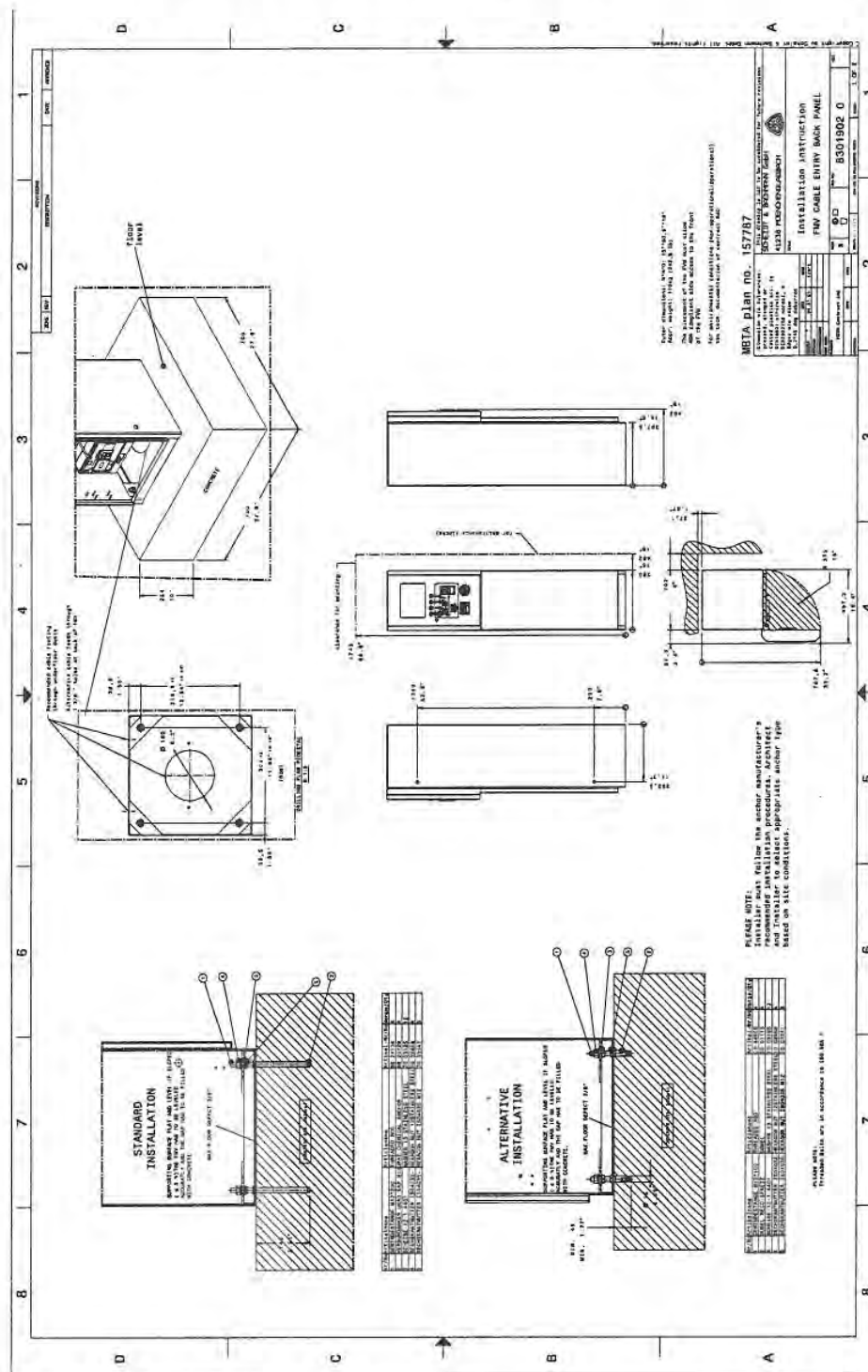


Figure 11-3 FMV Installation Instructions (for example only)

11.5 Site Preparation

Before installing the FMVs, prepare the designated location with a concrete platform having a recommended depth of 6" (Figure 11-3 and Figure 11-4). Conduits and pull through cables must be in place.

Existing cabling should be checked beforehand for completeness and functionality.

The concrete platform with the recommended dimensions (length 27.56 in. and width 19.69 in.) must be in place and must have a pressure firmness of 25 N/mm² (3650 PSI) (Figure 11-4).

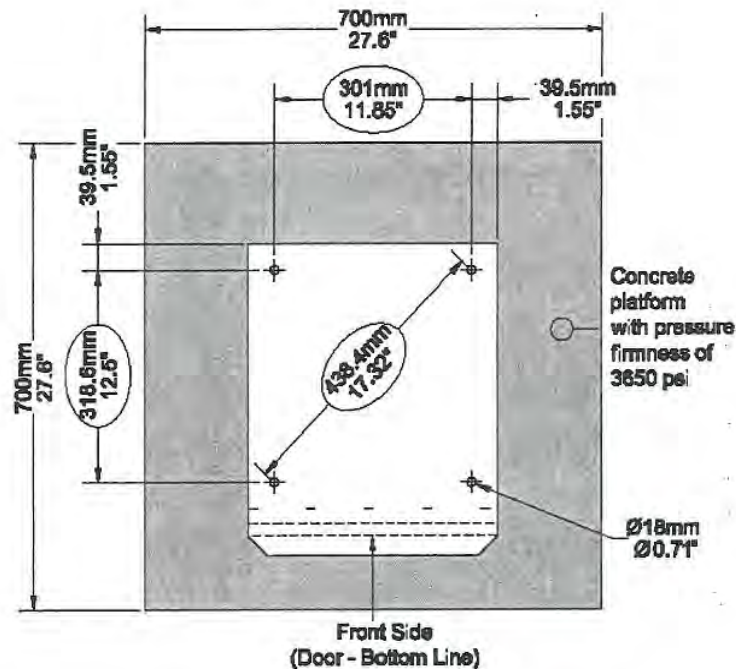


Figure 11-4 FMV installation site: Concrete platform and FMV footprint (The three dimensions in circles are distances between bolts.)

The concrete platform should not be more than 3% out of level, measured from bolt to bolt.



Alternatives to structural concrete may be used provided the dimensions of the solid platform are equal to or better than the 3650 psi specified by Scheidt & Bachmann. The bolts must be set in concrete.



Ensure that there is no power on any cable before starting the installation. Main Circuit Breakers must be shut off and all data cabling should be disconnected.

Ensure that there is no cabling, gas tubes, etc. near the proposed bolt location.



Protect bolt threads from damage by other installers and the general public. Damaged bolts prevent FMV installation! This is especially important for those installations using the long bolt!

11.6 Transport Equipment

The FMVs must be transported to the MBTA work site and then to the prepared installation location by the safest possible means.

11.6.1 Storage to Site

The installer must transport the FMVs to the MBTA work site by a safe, motorized means of transportation. Scheidt & Bachmann recommends enclosed trucks of sufficient size and weight bearing capability. The trucks should have motorized lift gates of sufficient capability to lift or lower one pallet containing one fully packaged FMV at a time. The FMV should be transported to the work site upright and in the original Scheidt & Bachmann packaging.



When loading and unloading FMVs, secure the load to prevent the FMVs, as mounted on the pallet, from tipping over! The combination of FMVs and pallet may become unsteady and tip! The FMV must be transported upright and not allowed to tip over! Do not drop or bang the FMV!

11.6.2 Site Transportation

The tools shown in Figure 11-5 and Figure 11-6 are used to transport FMVs and to install FMVs on concrete platforms at the work site. As shipped by Scheidt & Bachmann, the FMVs will be mounted one to a pallet (skid). Scheidt & Bachmann recommends a pallet lifter similar to the WESCO Part # 272153, capacity 1,100 pounds. Scheidt & Bachmann recommends a machinery mover similar to the Rais-N-Rol 2000 pound capacity, Model # 260091, with binding accessories to secure the FMV while moving on sloped surfaces and stairs. These are examples. Other, similar or better tools may be used by the installer.



Use three or more people to transport and install each FMV!

FMVs should not be lifted with a crane!



The FMV must be transported upright and not allowed to tip over!



Figure 11-5 Pallet Lifter



Figure 11-6 Machinery Mover

11.6.3 Unpacking

The FMVs should be unpacked with great care. When shipped from Scheidt & Bachmann, each FMV is bolted to two four by fours. The four by fours are then screwed to a pallet (skid). They are then wrapped in plastic and packaged in heavy-duty cardboard material. The cardboard is carefully secured to protect the FMV from damage. Finally, plastic straps with metal clips are used to secure the FMV to the pallet.



FMVs are typically shipped two to a pallet, each on its own four by fours and packaged individually!

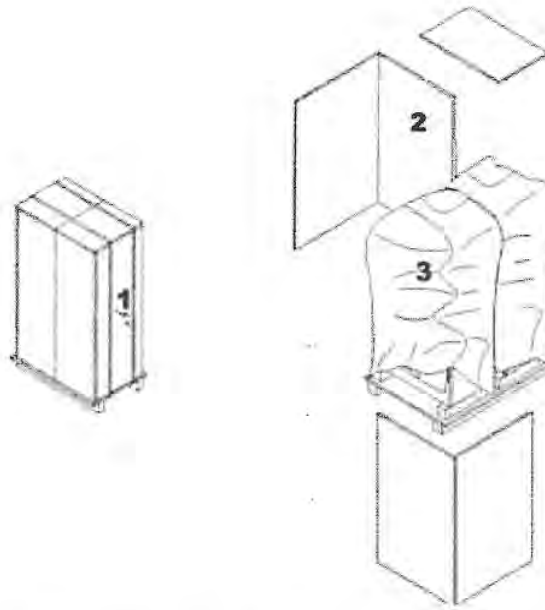


Figure 11-7 Unpacking the FMV

The FMVs should be unpacked in reverse order as described in the steps below.

- STEP 1:** Cut the plastic straps securing the FMV to the pallet (skid), **Figure 11-7, #1.**
- STEP 2:** Remove the cardboard outer packing, **Figure 11-7, #2.**
- STEP 3:** Remove one FMV from the pallet.
- STEP 4:** Secure the second FMV to the pallet.
- STEP 5:** Remove the plastic wrapping material from the FMV removed from the pallet in **Step 3, Figure 11-7, #3.**
- STEP 6:** Visually inspect this FMV for damage. Any damage should be noted and reported to Scheidt & Bachmann. Machines that pass the visual inspection are ready for installation.
- STEP 7:** Dispose of packing material.

Transport the FMV, while still on the four by fours, to its installation location. Instructions for removing the FMV from the four by fours are in section 11.9.



Keep the FMV securely attached to the four by fours until it is delivered to the installation location at the installation site.



Disposal of all packing materials is the responsibility of the installer installing the FMV.

Leave the second FMV on its shipping pallet (skid) until the crew is ready to remove it for installation at the same installation location. If the second FMV will be transported to another installation location, secure it to the shipping pallet (skid) to prevent any tipping, falling, or damage from other cargo.



Keep the unused FMV securely attached to the pallet (skid) until it is removed for installation at the current installation site or until it is delivered to another installation site.

11.7 Installation Tools and Equipment

The following special equipment and standard tools are required for FMV installation.

11.7.1 FMV Pedestal Mounting and Drilling Tools

Description	Illustration
Scheidt & Bachmann drilling template	
Hammer drill and drill suitable for anchors	
Brush	

Table 11-3 Mounting and Drilling Tools






Description	Illustration
Blow-out pump	
Four (4) bolts	
Vacuum cleaner	
Standard tools: Socket wrenches, Open-end wrenches, Bubble level	
Other tools: Silicone caulk, two wooden four by fours (minimum cross section: 3 x 3"; minimum length 30")	

Table 11-3 Mounting and Drilling Tools

11.7.2 Needs and Requirements for FMV Installation

The following preconditions must be met before installing the Fare Media Validator (FMV).

The installer must check the following items:

- ☒ Is there enough space available for the FMV Body and clearances?
- ☒ Is a 120V power outlet available within 8 feet of the equipment location?
- ☒ Use a volt meter or similar device to verify the 120V power supply is operational and providing adequate power.
- ☒ Are all power and communication cables to the FMV terminated and labeled correctly when compared to the station drawings?
- ☒ Is the communication cabling present and working? Use appropriate test devices to test continuity. Use a computer device to test TCP/IP ping from

end-to-end and from the location of the test device to the Central Computer System location.



- ☒ Are the required electricians available? Verify both the licenses and permits of the electricians.
- ☒ Are the FMV body and installation components available? Check the parts available against this list and the Bill of Materials.
- ☒ Is a regular metric tool set available? A 174 piece SAE/Metric tool set with 4 drive tools, 10 wrenches, and 121 additional tools, similar to the Alltrade 320329 Tool Set with Tool Box, should have all the necessary tools to make any adjustments, connections, or installations required.
- ☒ Are a pencil and pad of paper available for note taking, such as noting IP addresses, and check list verification?
- ☒ Is a drill suitable for the chosen anchoring system available?
- ☒ Are cable binders available? Panduit cable binders in these sizes are most useful: 3 7/8 inches by .098 inches (99 mm by 2.5 mm), 8 inches by .098 inches (203 mm by 2.5 mm), and 5 5/8 inches by .142 inches (142 mm by 3.6 mm).
- ☒ Verify with Central that the device is configured in the Central Computer System database and the software is available for download.
- ☒ Verify that all consumables are available. These include ticket stock.
- ☒ Shut down the main circuit breaker at the breaker panel so that no wires are "live" during installation. Use a volt meter to verify power is off.
- ☒ Use a cable test device to verify the continuity of cables from connector to connector to ensure the cables are ready to connect.
- ☒ For power wires, low voltage cables, and communication lines, use appropriate test devices.
- ☒ Are all required system keys available?
- ☒ Does the installer have access to all electrical and communication areas to ensure proper setup and installation?
- ☒ Are all doorways and other openings of sufficient size to ensure a proper transportation path from the curb side dropoff point to the final installation location?
- ☒ Are all the parts provided by other sources available?



11.8 Preparing Installation Location

The Installer must follow the steps below to prepare the installation location.

NOTE:

The Transit Authority is responsible for installing the FMV. A S&B technician verifies proper installation.

- STEP 1:** Check the location (see section 11.4).
- STEP 2:** Check that all materials are available. See section 11.7.1.
- STEP 3:** Check that all necessary tools are available. See section 11.6.
- STEP 4:** Check that all installation tools are available.
- STEP 5:** Remove all loose particles from the concrete platform and clean it thoroughly.
- STEP 6:** Use a bubble level to ensure that the concrete platform is level.
- STEP 7:** Place the template onto the designated concrete platform and align the template carefully.

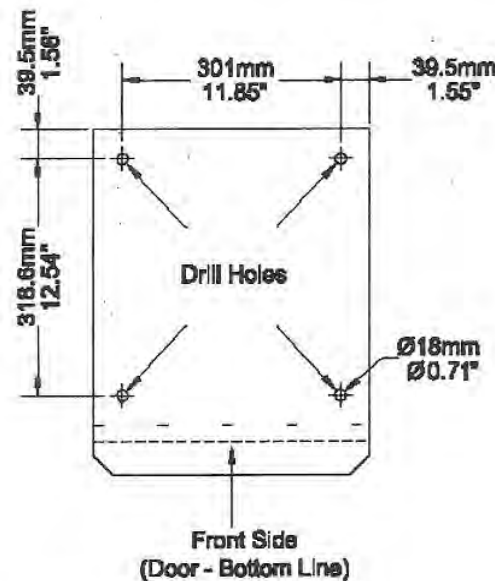


Figure 11-8 Drilling Template

- STEP 8:** Ensure that no cables, conduits, or gas lines are anywhere near the drill holes.
- STEP 9:** Ensure that openings in the concrete for conduits align with the breakouts in the FMV, so that cables will pass through with sufficient clearance.
- STEP 10:** Mark the locations of the drill holes with a permanent marker or color spray.
- STEP 11:** Remove the template from the designated site.

STEP 12: Drill four holes for the anchors using a hammer drill with a 1/2 inch bit for the expansion anchors. Drill four holes 1.77" (45 mm) deep for the expansion anchors. Be extremely careful. If the drill sticks, it can twist in your hands and cause serious injury.

STEP 13: Vacuum or blow out all drill holes as in **Figure 11-9**.

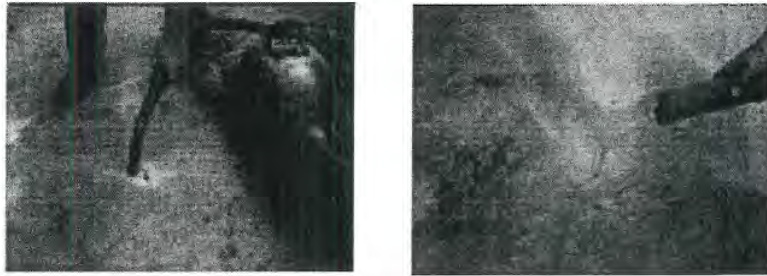


Figure 11-9 Vacuum or drill out drill holes



Figure 11-10 Drill Holes for the Bolts



Be extremely careful. If the drill sticks, it can twist in your hands and cause serious injury.

STEP 14: Clean the concrete platform thoroughly and ensure that all loose particles are removed.

STEP 15: Insert the expansion anchor (**Figure 11-11**) into the thoroughly cleaned drill holes.



Figure 11-11 Expansion Anchor



Alternatives to structural concrete may be used provided the dimensions and firmness of the solid platform are equal to or better than the 3650 psi specified by Scheidt & Bachmann. The bolts must be set in concrete.



The expansion anchoring system has been used in the past, successfully. Our installation recommendations apply to typical installations. For non-typical structures, it is an engineering decision by the Station Architect to choose an anchor or fastener that secures the FMV. The solution presented herein represents the minimum standards and specification. The MBTA and their engineers may determine that some installations need something more, because of the unique situation found at that location. However, in any case, the device is mounted on four 1/2 bolts.

11.9 Installing the FMV

Transport the FMV, using a pallet lifter, machinery mover, or similar device, to its exact installation location, see section 11.6.2.

Follow the steps below to install FMVs.

STEP 1: Check the location (see section 11.5).

STEP 2: Check the FMV and FMV materials (compare to materials list) to ensure all materials have been supplied.

STEP 3: Clean the concrete platform thoroughly and ensure all loose particles have been removed.

STEP 4: Unpack the FMV. Please refer to section 11.6.3 and Figure 11-7.



Scheidt & Bachmann recommends that the cable entry be located only underneath the FMV. If the cable is located elsewhere, Scheidt & Bachmann will not take any responsibility for the consequences. The consequences of locating the cables somewhere other than underneath the FMV can be (but are not limited to):

- Cables can be cut
- Wires can melt

STEP 5: Carefully open the FMV door with two "A" Keys.



THE POSITION OF THE CENTER OF GRAVITY IS DEPENDENT ON THE DESIGN OF THE FMV AND CAN BE OFF-CENTER. TO AVOID TIPPING THE FMV, ONE PERSON MUST HOLD THE FMV DOOR. ANOTHER PERSON SHOULD HELP STEADY THE FMV.

STEP 6: Use a 17mm open-end wrench to loosen the nuts from the four by fours.

STEP 7: Remove the four nuts, the four washers, and the four shipping bolts that secured the four by fours to the FMV. Remove the four by fours.

STEP 8: Carefully close and lock the FMV door.

STEP 9: Place a washer, a nut, another nut, and another washer, in that order, on each of the anchor bolts as shown in Figure 11-12.

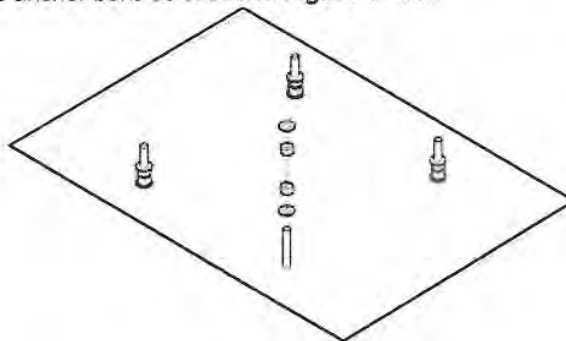


Figure 11-12 FMV Installation - 1

STEP 10: Place the four by fours in between the anchors.



STEP 11: Carefully lift the FMV onto the four by fours. Three people must be present. Center the FMV on the four by fours.



THREE (3) PEOPLE ARE NECESSARY TO LIFT THE FMV AND TO LOWER THE FMV OVER THE ANCHORS AND ONTO THE FLOOR.

STEP 12: Use the Key to carefully open the FMV door.

STEP 13: Align the four holes in the bottom of the FMV to the four anchor bolts in the concrete pad. (Figure 11-13).



THE POSITION OF THE CENTER OF GRAVITY IS DEPENDENT ON THE DESIGN OF THE FMV AND CAN BE OFF-CENTER. TO AVOID TIPPING OVER THE FMV, ONE PERSON MUST HOLD THE FMV DOOR.

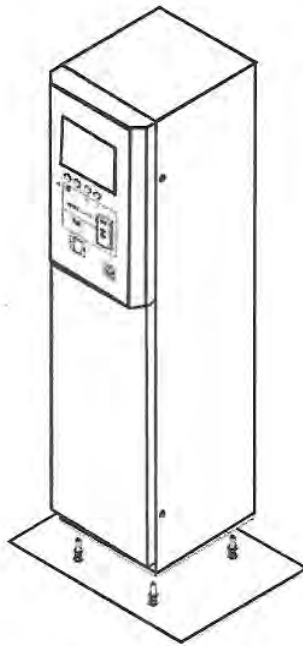


Figure 11-13 FMV Installation - 2

STEP 14: Two of the three people should carefully lift the FMV until both four by fours are removable.

STEP 15: The person in front of the FMV removes both four by fours.

STEP 16: All three people carefully lower the FMV until the anchor bolts pass through all four holes and the FMV touches the floor (Figure 11-13).

STEP 17: Unlock and open the FMV door.

STEP 18: On each bolt, ensure the bottom washer is in place and tighten the nut.

STEP 19: Loosely tighten the topmost nut on each bolt to the FMV frame.



The method used for installing the FMV and FMV-cashless machines onto the pedestals -- removing one four by four and lowering one side of the machine, then removing the other four by four and lowering the remaining side of the machine, will not work for mounting the FMV onto the bolts because there is not enough clearance! The FMV is light enough that the steps above should be followed.

STEP 20: Place a 1/2" nut with a washer on each bolt. Loosely tighten each nut with a 19 mm (3/4") open-end wrench.

STEP 21: Use a bubble level to ensure the FMV is level. If necessary, washers may be used for leveling. If a stack of washers more than 1/2" thick is required, use cement to level the FMV as shown in **Figure 11-14**.

STEP 22: When you are finished, close and lock the FMV door.



Using washers to level the FMV requires lifting the machine so that washers may be placed in position over the bolts. Follow all necessary precautions.

Using cement to level requires removing the FMV, using quick-drying cement, and reinstalling the FMV by following the steps above.



Scheidt and Bachmann highly recommends that all installation locations be level before attempting to install the FMVs. Leveling of 2° is possible by following the steps in "Minor Leveling Procedure" on page 22.

STEP 23: Seal the gap between the FMV and the platform with silicone caulk. Please see **Figure 11-16**.

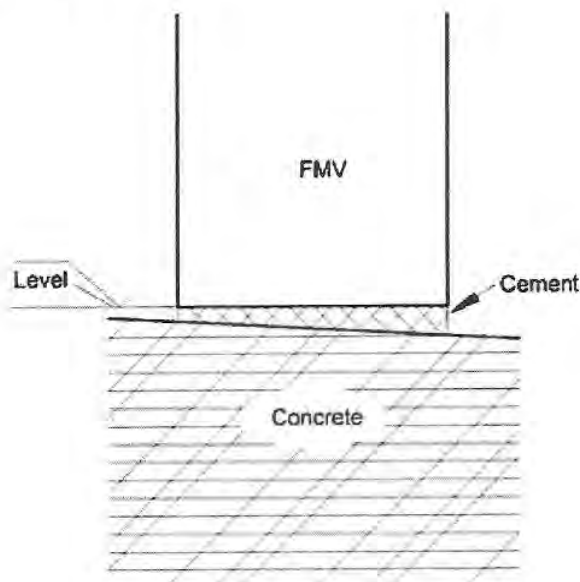


Figure 11-14 FMV Leveling



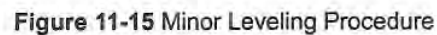


Figure 11-15 should be used with the following steps describing how to level the FMV within a 2° range.

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**11.9.2 FMV Main
Power
Installation**

The following steps are common to both long and short bolt installation procedures and must be followed.



Ensure power to all cables is shut off before starting the installation. Main Circuit Breakers must be shut off and all data cables should be disconnected.

STEP 8: An authorized electrical worker should connect the power cable as shown in Figure 11-16 and also Figure 11-18.

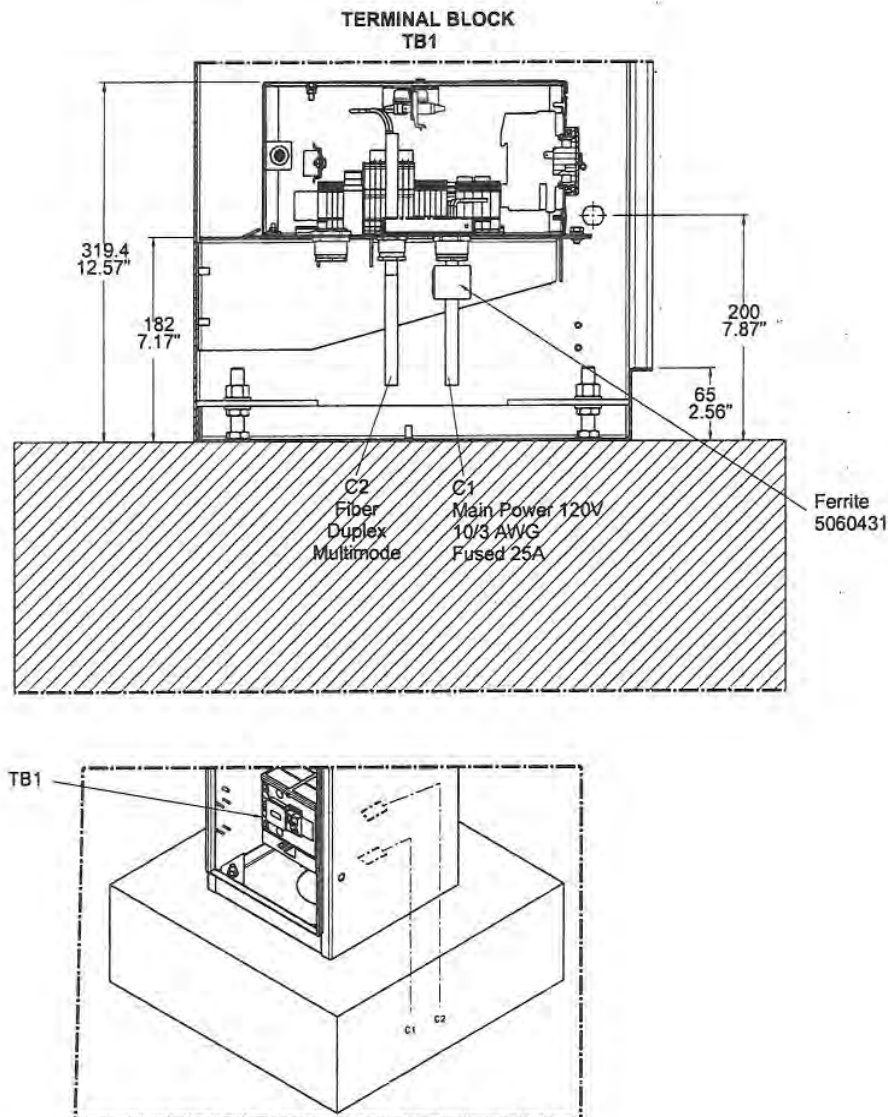


Figure 11-16 Power Connection Diagram



NOTE:

Use the network connection kit to connect the fiber cables: Fiber duplex Multimedia (0339318).

Cable ID	Function	Cable Type *	Origins from	Terminal # at origin point (wire ID)	Destination	Terminal # at destination point (wire ID)	Wire Marking or Color	Approximate Length (ft)	Supplied By
C1	Customer power supply, 120VAC, 60Hz, 25A minimum	As per applicable local building standards, AWG #10 or larger section conductors (capacity for 25A minimum)	Building	HOT	TERMINAL BLOCK TB1	L1	Black	Site dependent	Others
				NEUTRAL		N	White		
				GROUNDING		GND	Green		
C2	Communications with central system	Fiberoptic	MBTA Central System Network		TERMINAL BLOCK TB1	SG - Connector	By others	Site dependent	Others

Table 11-4 Cable Details

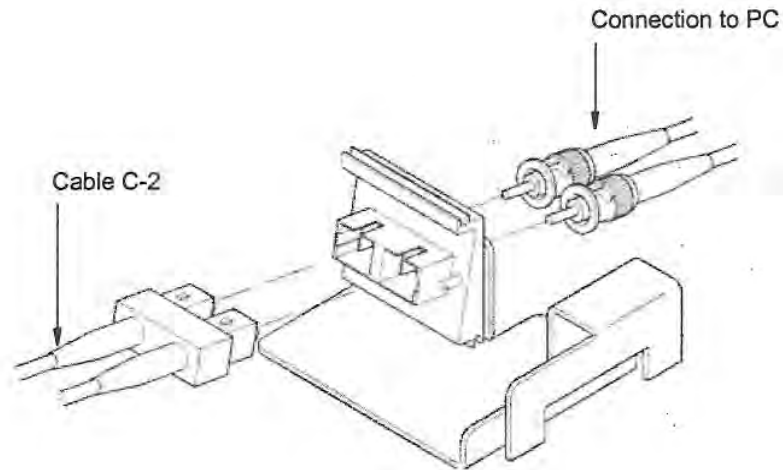


Figure 11-17 Network Connection

- Open the FMV door. Two keys must be used, one in each lock, because door keys may be removed only when the lock is in the "lock" position.

NOTE:

Use two keys to open the FMV front door locks!

[illegible]

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SECTION 13126

PREFABRICATED BOOTHS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. This Section specifies the following:
 - 1. Fabrication and installation of an MBTA Inspector's Booth as shown on the Plans and as described herein. The Inspector's Booth shall be a minimum of eight feet (8') long; and four feet (4') wide.
 - 2. Work of this Section also includes all glazing, doors, painting, hardware, interior finishes, security systems, electrical systems, HVAC, and millwork, for each booth and enclosure.
 - 3. Provide all security systems required for booths.
- B. Work shall include, but not be limited to, providing all materials, methods, equipment, specified herein, and installation for the complete booths and enclosures.

1.2 RELATED WORK

- A. Carefully examine all of the Contract Documents for requirements which affect the work of this Section.
- B. Other specification sections that relate directly to work of this Section include, but are not limited to, the following:
 - 1. Division 16, ELECTRICAL; for electrical connections including conduit and wiring for power and lighting.

1.3 QUALITY ASSURANCE

- A. Source: Provide booths and enclosures that are products of one manufacturer. Provide secondary or accessory materials that are acceptable to manufacturers of primary materials.
- B. Installer: A firm that is acceptable to the manufacturer of the booths and enclosures.
- C. Coordination: Coordinate electrical and security equipment and conduit stub-up locations with requirements of Division 16 before installation of the Booth.

4. Booth Intercom: Install booth intercom systems complete and operable in accordance with the following:
 - a. National Electrical Code
 - b. MBTA Manual of Guidelines and standards
 - c. Manufacturer's recommendations

PART 4 - MEASUREMENT AND PAYMENT

4.1 GENERAL

A. Concrete foundation pad for the Prefabricated Booth shall be measured and paid for under Contract Unit Price for Item 901. – 4000 PSI, 1.5 IN., 565 CEMENT CONCRETE.

- B. Separate Measurement and Payment will not be made for **all other** work of this Section complete in place, but all costs, therefore, shall be included in the Contract Lump Sum Price for Item No. 745.02 – MBTA Inspector's Booth.

END OF SECTION

SECTION 13127

MBTA TEMPORARY COMFORT STATION

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. This Section specifies the following:
 - 4. Fabrication and installation of a temporary MBTA Comfort Station as shown on the Plans and as described herein. The Temporary Comfort Station shall be a minimum of sixteen feet (16') long; and twelve feet (12') wide.
 - 5. The Temporary Comfort Station shall include separate men's and women's toilets and wash room facilities.
- B. Work shall include, but not be limited to, providing all materials, methods, equipment, specified herein, and installation of the complete temporary comfort station.

1.2 RELATED WORK

- A. Carefully examine all of the Contract Documents for requirements which affect the work of this Section.
- C. Other specification sections that relate directly to work of this Section include, but are not limited to, the following:
 - 2. Division 16, ELECTRICAL; for electrical connections including conduit and wiring for power and lighting.

1.3 QUALITY ASSURANCE

- A. Coordination: Coordinate electrical equipment with requirements of Division 16 before installation of the Comfort Station.

1.4 SUBMITTALS

- A. Shop Drawings: Prepare and submit for the Engineer's approval six complete sets of shop drawings which shall indicate all materials, finishes, sizes thicknesses, joint locations, restroom fixtures, holding tank, electrical devices and conduits, and all other components that are part of the temporary comfort station work.
 - 3. Do not fabricate any material or proceed with any Work until shop drawings have been obtained.
 - 4. Submit shop drawings showing locations of electrical and mechanical equipment, wireway routing, and installation methods.

1.5 DESIGN STANDARDS

- A. The requirements of this Section are based on designs as shown on the Contract Drawings and the Authority's design standards.
 - 1. The configuration and location of the temporary comfort station shall be as indicated on Contract Drawings.

PART 2 - PRODUCTS

2.1 MATERIALS FOR TEMPORARY COMFORT STATION

- A. The temporary comfort station shall consist of a two-stall restroom (one men's room and one woman's room) with the following features:
 - 6. Flushing Porcelain Toilets
 - 7. Porcelain Urinal (men's room side)
 - 8. Vanities and Mirrors
 - 9. Vanities and Mirrors
 - 10. Soap Dispensers
 - 11. Paper Towel Dispensers.
 - 12. Heating and Air Conditioning Units.
 - 13. Indoor and Outdoor Lighting
- B. The temporary comfort station shall include a Mechanical Room serving the restrooms, and include the following elements:
 - 1. Water supply or a 125 gallon (minimum) water holding tank:
 - 2. Sewer waste line or a 350 gallon (minimum) waste holding tank
- C. Exterior of Building
 - 1. Provide separate doorways with inside locks
 - 2. Occupancy light indicators
 - 3. Stairway with handrails if required.

PART 3 - EXECUTION

3.1 CONSTRUCTION METHODS

- A. Construct concrete foundation pad for the temporary comfort station in accordance with the MassDOT Standard Specification Section 900 and Section 03300 – CAST IN PLACE CONCRETE, contained herein.
- B. Water and/or Sewer connections shall conform to the requirements of the City of Chelsea Department of Public Works. Holding Tanks shall conform to the relevant provisions and requirements of the Massachusetts Department of Environmental Protection.

PART 4 - MEASUREMENT AND PAYMENT

4.1 GENERAL

- A. Concrete foundation pad for the Temporary Comfort Station will be measured and paid for under Contract Unit Price for Item 901. – 4000 PSI, 1.5 IN., 565 CEMENT CONCRETE.**
- B. Separate Measurement and Payment will not be made for **all other**work of this Section complete in place, but all costs, therefore, shall be included in the Contract Lump Sum Price for Item No. 746.01 – MBTA Temporary Comfort Station.

END OF SECTION

SECTION 16050

BASIC MATERIALS AND METHODS FOR ELECTRICAL WORK

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. This Section specifies basic materials and methods for electrical work.
- B. The work under this Section shall include furnishing all labor, materials, equipment, tools, transportation and services necessary to construct and install and complete conduit and wiring system and other work as shown on the Contract Plans and specified herein. This shall include, but not be limited to, all excavation, backfilling, conduit, wiring, fasteners, splices, terminal connectors and all incidentals necessary to provide a complete system.
- C. All work performed and all materials furnished shall be in reasonably close conformity with the dimensions, details, physical and chemical characteristics and other specific requirements of the contract.

- D. Excavation for placing or construction of any of the items shall be made to the minimal practicable limits. Where, in the opinion of the Engineer, the base on which an item is to be founded is unsuitable, as a foundation, the Engineer may direct further excavation and backfilling with gravel borrow to the elevation of the proposed base of the foundation.

Where rock is encountered in the course of excavation, only the rock that will interfere with proper placing of the item shall be removed. Backfill, in general, shall be with the material obtained from the excavation, compacted in layers not exceeding six inches in depth before compaction.

- E. Wherever in the course of operation it is necessary to temporarily remove parts of existing facilities or other construction in order to do the directed work, the Contractor shall finally replace and restore the construction in kind. Separate payment will not be made for the components of the work for which such removals are made but all associated costs shall be included in the lump sum costs and shall be considered incidental to the items of work to which they pertain.
- F. The Contract price for the lighting system as described hereinafter and as listed in the proposal includes all materials complete in place as part of the entire system, whether the component parts of the system are specifically mentioned or whether they are implied by the nature and satisfactory operation of the system.
For example, all appurtenances implied under "fixture" (e.g., luminaires brackets, ballast, photocell, etc.) are included in the contract lump sum price for the system. This example is not restricted to fixtures; it is applied equally and similarly to all items. Fuses and circuit breakers are considered as part of the item in which they are placed.

- G. **The contractor shall contact NSTAR to acquire the short circuit conditions at each location for the new electrical services to be installed. The contractor shall perform short circuit coordination and arc flash studies for these new electrical services. The**

ratings of the electrical equipment shall be based on the results of these studies. The studies shall be reviewed and approved by the engineer before releasing the submitted electrical equipment for procurement and installation.

1.2 REFERENCES

A. Comply with applicable requirements of the following:

1. National Electrical Code
2. Massachusetts Electrical Code

1.3 SUBMITTALS

A. Submit shop drawings for review showing fabricated work being furnished and installed under these Specifications. Submit such drawings prior to fabrication and within ample time to prevent delays in the work.

B. Submit verified test results to the Engineer promptly upon completion of test.

C. Before installation of the wire and cable, submit the following information for each type and size of wire and cable for review:

1. Manufacturer of the wire and cable.
2. Number and size of strands composing each conductor.
3. Conductor insulation composition and thickness in mils.
4. Average overall diameter of finished wire and cable.
5. Minimum insulation resistance in megohms per 1000 feet at 20°C ambient.
6. Jacket composition (if any) and thickness in mils.
7. Total number of conductors per cable.
8. Shield material (if any) and thickness.
9. Conductor resistance and reactance in ohms per 1000 feet at 20°C ambient.
10. Conductor ampacity at 20°C ambient.

D. Prior to installation of any wires, factory certified test reports shall be submitted to the Engineer for approval. The tests shall include, but not be limited to, dielectric withstand and insulation resistance tests as specified under U.L. Standard U.S.-44 "Rubber Insulated Wire and Cable" or U.L. Standard U.S.-83 "Thermoplastic Insulated Wires."

E. Within 30 days following execution of the Contract and prior to ordering the area lighting poles, luminaires, and wiring from the manufacturer, the Contractor shall visit the project site and become familiar with all aspects of the proposed lighting system. Shop drawings shall then be submitted to the Engineer for approval in accordance with the Standard Specifications. The shop drawings submitted for approval shall include poles, luminaires, lamps, brackets, all wires, and cables, splicing materials, pull boxes, junction boxes, foundations, conduit and fittings, panel boards, contactors, wire ways, cabinet and components, aerial cable and messenger wire, wood poles, wood pole fittings, wood pole hardware, brackets, guy wires, butt support poles, ground rods, ground wire, ground connectors, clamps and components, etc.

F. No work shall be commenced by the Contractor until he has approval of the drawings in writing from the Engineer. Approval of these drawings will be general in character and shall not mean that the drawings have been checked so as to relieve the Contractor from the responsibility of or the necessity of furnishing materials and workmanship required by the plans and these

- E. During the construction period, the Contractor shall adequately protect all electrical equipment and materials against damage and shall replace all damaged and defective electrical materials and equipment.
- F. All exposed surfaces, including panels, apparatus, lighting fixtures, lenses, lamps, devices, device plates, and all other electrical equipment shall be thoroughly cleaned

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. Furnish all items of the materials, design, sizes, and ratings shown on the Contract Drawings and herein specified.
- B. Furnish materials and equipment bearing evidence of UL listing where UL standards exist and such product listing is available.
- C. Methods of fabrication, assembly and installation are optional unless otherwise specifically indicated.
- D. Provide products that are free from defects impairing performance, durability, or appearance, and of the commercial quality best suited for the purpose shown on the Contract Drawings or specified herein.
- E. Steel conduit and accessories specified to be zinc coated: Hot-dipped galvanized after fabrication in accordance with ASTM A286.
- F. Conform to applicable requirements of Insulation Power Cable Engineers' Association (IPCEA).
- G. All equipment, devices, materials, etc. shall be new and capable of integration into the system and subsystems specified within these Specifications.
- H. The material and apparatus required for the work to be performed is specified within the respective Sections of these Specifications.

2.2 RIGID GALVANIZED STEEL CONDUIT AND ACCESSORIES

- A. Conduit, couplings, elbows, bends, and nipples: ANSI C80.1 and UL 6, with each length bearing manufacturer's stamp and UL label.
- B. Method used to determine the thickness of zinc coating: The Referee Test included in the appendix to ANSI C80.1.
- C. Fittings and Accessories:
 - 1. Galvanized steel or malleable iron, ANSI C80.4.
 - 2. Provide separable watertight hub fittings with a gasket, separate nylon insulated throat and a case hardened locknut.
 - 3. Bushings: Nylon insulated metallic and grounding type.
 - 4. Furnish conduit straps, clamps, and clamp backs made of galvanized malleable iron.

- D. Conduit shall be rigid galvanized steel, size as shown on the drawings. Electrical Metallic Conduit (EMT) is not allowed.
- E. **Rigid Galvanized Steel (RGS) conduit shall be used in above ground and for use in enclosures, buildings, shelters, etc.**

2.3 PVC ELECTRICAL CONDUIT AND FITTINGS (ONLY FOR OUTDOOR USE)

- A. Heavy wall, high impact strength, rigid PVC conforming to the requirements of EPC-40-PVC conduit of NEMA TC2 and fittings for EPC-**80**-PVC conduit of NEMA TC3.
- B. UL listed in accordance with Article 347 of the NEC for underground and exposed use.
- C. Flammability rated as self-extinguishing, and having the following minimum properties:
 - 1. Tensile strength, ASTM D638 at 78°F: 6,000 psi.
 - 2. Flexural strength, ASTM D790: 11,000 psi.
 - 3. Compressive strength, ASTM D695: 8,500 psi.
 - 4. Hardness (Durometer D), ASTM D2240: 77.
 - 5. Water absorption, percent maximum, in 24 hours at 72°F. ASTM D570: 0.03.
 - 6. Dielectric strength, volts per mil, ASTM D149: 1,100.
 - 7. Thermal conductivity: 1.3 BTU per square foot per degree F per inch.
- D. Use 2" and 1 ½" inside diameter Schedule **80** PVC for concrete encased PVC conduit, size as shown on the drawings. Rigid Galvanized Steel conduit sweeps to be used rising to above grade from below grade concrete encased PVC conduit **and PVC conduit encased in concrete structures.**

2.4 CONDUIT EXPANSION FITTINGS

- A. Fabricate from material similar to the type of conduit with which they are to be used.
- B. Include a factory installed packing ring, designed to prevent the entrance of moisture, and a pressure ring.
- C. Also include a grounding ring or a grounding conductor for metallic expansion couplings.

2.5 MULTIPLE PIPE HANGERS (TRAPEZE TYPE)

- A. Fabricate of two or more steel hanger rods, a steel horizontal member and all U-bolts, clamps, and other attachments necessary for securing hanger rods and conduits.
- B. Hanger Rod: Not smaller than 3/8 inch diameter, threaded either full length or for a sufficient distance at each end to permit at least 1-1/2 inches of adjustment.
- C. Horizontal Member
 - 1. Standard structural steel shapes such as angles or channels, 1-1/2 by 1-1/2 or 1-5/8 by 1-5/8 inches, 12 gauge, cold-formed, lipped channel, and designed to accept special spring-held hardened steel nuts for securing hanger rods and other attachments.

2. Two or more channels may be welded together to form horizontal members of greater strength than single channels.
3. Galvanize after fabrication.

D. Design

1. Capable of supporting a load equal to the sum of the weights of the conduits and wires, the weight of the hanger itself, plus 200 pounds.
2. The stress at the root of the thread of the hanger rods; not more than 9,475 psi at design load.
3. Size the horizontal member such that the maximum stress will be not more than 12,650 psi at design load.

2.6 INSERTS

- A. Channel Inserts.** Fabricate from not less than 12 gauge steel channel having an overall size of 1-1/2 by 1-1/2 or 1-5/8 by 1-5/8 inches with continuous 7/8 inch wide slot, in lengths as indicated. Galvanize after fabrication.

B. Channel Inserts for Embedding in Concrete

1. Fabricate from channels having a solid base.
2. Weld concrete anchors to the channel during fabrication and before coating.
3. Galvanize after fabrication
4. Provide assemblies with a minimum pull-out load rating of 4,500 pounds per linear foot uniformly distributed.
5. Furnish all channel inserts for installation embedded in concrete with the channel interior completely filled with styrofoam to prevent seepage of concrete into the channel during installation.

C. Channel Inserts for Surface Mounting

1. Fabricate from channel having 3/8 inch by 3-inch slots on 4-inch centers in the base.
2. Galvanize inserts for surface mounting on concrete surfaces or for installation in damp or wet areas.

D. Spot Inserts for Embedding in Concrete

1. Steel, galvanized after fabrication
2. Designed for a maximum loading of 800 pounds with safety factor of three.
3. Knockout openings to accommodate either square or rectangular nuts.

2.7 SURFACE METAL RACEWAYS AND FITTINGS

- A.** ANSI/UL 5 and the NEC.

2.8 OUTLET, JUNCTION AND PULL BOXES

- A.** Conform to NEC Article 370. Electrical boxes shall conform to UL-50, "Standard for Electrical Cabinets and Boxes", and UL-514, "Standard for Electrical Outlet Boxes and Fittings".

- B. Provide electrical boxes of the material, finish, type and size indicated and required for the location, kind of service, number of wires, and function. Boxes shall have mounting holes retapped for 10-24 machine screws.
- C. Provide boxes complete with accessible covers designed for quick removal and suitable for the purpose for which they will be used, except that boxes in which or on which no devices or fixtures are to be installed, shall be equipped with flat or raised blank covers as required. All ceiling fixture outlet boxes shall be equipped with 3/8-inch boltless fixture studs.
- D. Boxes not over 100 cubic inches in size shall be cast. Boxes over 100 cubic inches in size shall conform to the requirements for cabinets.
- E. Covers: Same thickness as boxes and secured in position by means of No. 10-24 stainless steel machine screws. Arrange covers to be readily and conveniently removed.
- F. Coat junction boxes inside and outside to prevent oxidation. Where outlet boxes are used as junction boxes they shall be cast aluminum and not be smaller than 4 inches square by 1-1/2 inches deep. Provide such boxes with flat blank covers.
- G. Outlet Boxes: Cast aluminum, not be smaller than 4 inches square by 2-1/8 inches deep.
- H. Concealed Switch Boxes: Cast aluminum, not less than 4 inches square by 1-1/2 inches deep for two devices unless otherwise indicated. Provide covers with rectangular openings of proper size and shape. Furnish and install special boxes required to suit the kind of service and location requirements, as indicated, and as may be directed by the Engineer.
- I. Cast metal boxes shall be of aluminum alloy, with compatible conduit fittings.
- J. Boxes for exposed switches and receptacles: Cast metal, FS and FD Types.
- K. Furnish brackets, supports, hangers, fittings, bonding jumpers and all other accessories required.
- L. Provide neoprene gaskets 1/8 inch thick with boxes subjected to weather, and as directed by the Engineer.
- M. Grounding. Provide each box to which a lighting fixture or receptacle is to be attached with a grounding terminal.
 - 1. Grounding Terminal: Either a green-colored washer-in-head machine screw not smaller than No. 10-32 in a drilled and tapped hole in the back of the box, or a grounding bushing with green-colored machine screw terminal attached to one of the conduits.
 - 2. Provide suitable grounding terminals in motor connection boxes.
 - 3. Install grounding jumpers as specified in Section 16450 - GROUNDING.
- N. Junction and pull boxes must be surface mounted and not buried.

2.9 UNDERFLOOR DUCTS, TRENCHES, AND FITTINGS

- A. Manufacture ducts and trenches from 14 gauge galvanized steel, furnished with a UL listed corrosion-resistant coating.
- B. Design fittings for use with the duct or trench to form a complete underfloor raceway system.

- C. Ducts for Power Service: 3-1/8 inches wide by a minimum 1-1/4 inches deep, or 6 inches wide by 1-1/2 inches deep, as indicated, with threaded 2 inch IPS inserts spaced on 2-foot centers.
- D. Ducts for Low Voltage, Communication, or Signal Use; Six inches wide by 1-1/2 inches deep with 2-inch IPS inserts spaced on 2-inch centers.
- E. Floor Trenches: 18 inches wide by 4 inches deep with 5/16-inch thick floor plate. Cover plates of maximum length, as indicated.
- F. Equip inserts with caps and countersunk-head floor marking screws.
- G. Size junction boxes for underfloor ducts to accommodate the ducts, and finish similar to the duct.
- H. Provide approximate tile holders of a depth as required for installation of the floor finish.
- I. Provide service fittings where required, complete with adapters and locking nipples suitable for use with the duct.

2.10 WIRE AND CABLE (600 VOLT)

- A. Conductors: Conform to the requirements of the NEC.
 - 1. Feeder and Branch Circuit Conductors: Soft-drawn copper.
 - 2. Control Circuits: Soft-drawn copper.
 - 3. Conductor Sizes: Standard American Wire gauge sizes. Conductors No. 10 and smaller, solid copper; No. 8 and larger, stranded copper.
 - 4. Minimum AWG sizes unless otherwise indicated:
 - a. No. 12 for branch circuits.
 - b. No. 14 for control wire and fixture wire
 - c. No. 16 for low voltage circuit and indication wire.
 - 5. Wire shall be No. 10 AWG, type XHHW for luminaire feeder circuits from the lighting fixture elevation level for wood pole mounted lighting fixtures, or from the base of metal pole, or from adjacent handhole to luminaire.
 - 6. The feeder wires from the branch circuit cables to the luminaires shall have a pin and receptacle type connector in each line at the lighting fixture elevation level for wood pole mounted lighting fixtures, and at the base of a metal pole. The connector shall have a waterproof housing capable of being disconnected without damage. The connectors in the phase wires shall be the fused type and shall be fused at 15 amps. The neutral wire shall have an unfused connector.
 - 7. All other connections except for the connection at the base of metal pole shall be insulated by using a cast insulation of self-curing epoxy resin which is compatible with the wire insulation to form a moisture resistant joint, The resin shall be poured into rigid molds of dimensions suitable for the splice.
- B. Wire and Cable 600 volts and Below Installed Raceways: Single conductor, NEC type XHHW, conforming to requirements of NEMA WC 7, or THWN.
- C. Fixture Wire: Type AF single conductor, rated for 150°C conductor temperature, 300 volts.
- D. Color Coding of Conductors

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**SECTION 16325
CONDUIT SYSTEM**

PART 1 - GENERAL

1.01 DESCRIPTION

- A. This Section specifies furnishing and installing various types of conduits and duct bank systems to include conduit, concrete encased duct banks, handholes and associated appurtenances as specified herein and as shown on the Contract Drawings.

1.02 QUALITY ASSURANCE

- A. Workmanship shall conform with the best modern practices for a rugged, long-lived, safe installation required for a public transportation system. Materials to be installed shall be new and of the highest commercial grade as specified.

1.03 SUBMITTALS

- A. The Contractor shall submit the following for approval:
 - 1. Catalog cuts and descriptive literature for all materials as specified herein and as shown on the Contract Drawings.
- B. "As-Built" drawings, prior to Authority acceptance.

PART 2 - PRODUCTS

2.01 ELECTRICAL AND TELEPHONE MANHOLES AND HANDHOLES

- A. Manhole and Handhole structures shall be cast-in-place concrete conforming to the requirements of Section 03300 or precast concrete conforming to the requirements of Section **801 of the MassDOT Highway Division Standard Specifications for Highways and Bridges**, at the option of the Contractor.
- B. Handholes shall be furnished complete with conduit sleeves, reinforcing steel, frames and covers, drain sumps and other associated items as specified herein and as shown on the Contract Drawings.
- C. Precast units (if used) shall be the product of a manufacturer regularly engaged in the manufacture of precast concrete products.
 - 1. Concrete for precast work shall have an ultimate 28-day compressive strength of not less than 4,000 pounds per square inch. Handholes may be precast monolithically and placed as a unit; or, they may be of assembled sections, designed and produced by the manufacturer in accordance with the requirements specified. All structures shall be identified with the manufacturer's name embedded in, or otherwise permanently attached to, an interior wall face.

2. Design for assembled units: Precast structures shall be designed in accordance with ACI-318 and shall be based on the following properties:
 - a. Angle of internal friction equals 30 degrees. Unit weight of soil equals 110 pounds per square foot.
 - b. Lateral at rest earth-pressure coefficient equals 0.50 above water-table, equals 0.90 below water-table.
- D. Sump wells shall be provided in all handholes and shall be 12 inches square and 4 inches deep.
- E. Handhole sections shall conform to AASHTO M199 specification, except as modified herein.
- F. Handhole frames and covers shall be heavy-duty cast iron, suitable for H-20 wheel loading. Covers shall be vented for atmospheric testing as shown on the Contract Drawings. Each cover shall be casted with the logos "MBTA COMMUNICATIONS", "MBTA ELECTRICAL" and or as indicated on the Contract Drawings or as directed by the Engineer.
- G. Handhole frames, covers and ferrous hardware shall be hot-dipped galvanized after fabrication in conformance with ASTM Specification A123.

2.02 CONDUIT

- A. General. Conduits and fittings shall be free, within commercial tolerances, of objectionable lines, bubbles, chipped ends, and other manufacturing defects, that would impair the service of the conduit. The bore of the conduit shall be straight and circular in cross section with smooth interior surfaces free from obstructions and rough and flaky areas. The conduit and fittings shall be free from all substances that may injuriously affect any wire or cable covering. The numbers and sizes of the conduits shall be as shown on the Contract Drawings. At locations where conduits are required governed by these Specifications and as shown on the Contract Drawings, the various types of conduits to be furnished are specified below.
- B. Rigid Metal Conduit. Rigid metal conduit shall be used at locations as specified within these Specifications and as shown on the Contract Drawings. The types of rigid metal conduit to be used for the various applications shall be as follows:
 1. Galvanized Rigid Steel (RGS) Conduit
 - a. Steel conduit and fittings shall be made of the best grade standard weight steel pipe protected inside and outside by a coat of hot-dip galvanizing. Where sweeps are used, they shall be the long radius type. Steel conduits shall be protected in shipping and handling by approved thread protectors.
 - b. Galvanize Touch-Up. Where galvanizing is removed by welding or other assembly procedures, touch-up abraded areas with two coats of zinc-rich chromate paint designed for repair of galvanizing in accordance with ASTM Specification A780.

C.

D. PVC Schedule 80 Electrical Conduit

- a. Heavy wall, high impact strength, ridged strength PVC conduit shall be installed as indicated on the Contract Drawings.

2.03 CONCRETE ENCASED DUCT BANKS

A. Concrete and Formwork

1. All concrete used in duct banks shall conform to the requirements of Section 03300 for ASTM C150, Type II portland cement concrete. All formwork used shall conform to the requirements of Section 03100 and Section 901 of the MassDOT Highway Division Standard Specifications for Highways and Bridges.

B. Concrete Reinforcement

1. Concrete reinforcement shall be as indicated on the Contract Drawings conforming to the requirements of Section 03200 Section, and 901 of the MassDOT Highway Division Standard Specifications for Highways and Bridges.

2.04 DUCT SPACERS

A. Duct spacers shall be furnished for concrete encased duct banks and direct burial conduit application.

B. Duct spacers shall be made of high impact plastic, designed to maintain a 2-inch minimum spacing between conduits. Spacers shall be capable of interlocking any combination of duct sizes, horizontally and vertically, and all types of duct (FRE, Galvanized Steel).

2.05 PULL LINE

A. Pull line shall be 3/16" (minimum) in diameter with a tensile strength of 720 pounds (minimum). Pull line shall be of a polypro material, highly visible bright yellow and weather resistant.

2.06 BACKFILL

A. Backfill material shall conform to the requirements of Section 02300 and Section 801 of the MassDOT Highway Division Standard Specifications for Highways and Bridges.

2.07 CONDUIT MARKER TAPE

- A. Furnish polyethylene conduit marker tape (non-adhesive) over the conduit system. Tape shall be bright yellow, six inches wide and continuously coded in black lettering with the following legend:

CAUTION CAUTION CAUTION CAUTION
SIGNAL AND ELECTRICAL CABLE BURIED BELOW

2.08 GROUNDING

- A. Grounding material for electrical manholes and handholes shall conform to the requirements of Section 16450.

PART 3 - EXECUTION

3.01 EXCAVATION AND BACKFILLING

- A. Excavation and backfilling requirements shall be performed in accordance with Section 801 of the MassDOT Highway Division Standard Specifications for Highways and Bridges.

3.02 ELECTRICAL AND COMMUNICATIONS HANDHOLES

- A. Handholes shall be installed on eight inches of gravel (min.) or special borrow approximately in the locations as shown on the Contract Drawings. The exact locations shall be determined after careful consideration has been given to the location of existing and proposed utilities, drainage systems and grades.

3.03 CONCRETE ENCASED DUCT BANKS

- A. General
1. Conduits shall be wiped clean thoroughly before being installed.
 2. Couplings, adapters and fittings for the ducts shall be installed in accordance with the manufacturer's recommendation.
- B. Each single conduit of the duct bank structure shall be completely encased in concrete as indicated on the Contract Drawings. The thickness of concrete encasement indicated is the minimum thickness, and may be increased to fit the actual shape of the trench. Duct spacers shall be used to support the conduits both vertically and horizontally. Duct spacers shall be placed at 5 foot intervals (maximum). Ducts shall be anchored securely to prevent concrete encasement from deforming.
- C. The concrete structure and conduits shall be installed with a minimum continuous slope of six inches per one hundred feet. Duct banks shall slope downward toward the handhole; from one handhole to the next or in both directions from a high point between the handholes.

- D. Changes in direction of conduit runs exceeding a total of ten degrees, either vertical or horizontal, shall be accomplished by long radius bends which have a minimum radius of curvature of 25 feet, except that manufactured bends may be used at the ends of the run. The long sweep bends may be made up on one or more curved or straight sections or combinations thereof. Manufactured sweeps shall have a minimum radius of 36 inches, or 48 inches as required by the conduit size.
- E. During construction and after the duct bank is completed, the ends of the conduits shall be plugged to prevent water from washing mud or other obstructing material into the conduits. Particular care shall be taken to keep the ducts clear of concrete, dirt and any other substance during the course of construction. Where it is necessary to cut a tapered end on a piece of conduit at the site, the cut shall be made with a tool or lathe that is designed to cut a taper to match the taper of the particular conduit that is being used.
- F. After the duct bank structure has been completed, a standard flexible mandrel, not less than 12 inches long and approximately 1/4 inch less in diameter than the inside diameter of the conduit, shall be pulled through each conduit. After this, a brush with stiff bristles shall be pulled through each conduit to make certain that no particles of earth, sand or gravel have been left in the line. An approved pull wire shall be installed in each conduit after brushing and the ends shall be plugged in a manner that will positively prevent entry of foreign objects. Pneumatic rodding may be used to draw in the pull line.

3.04 DIRECT BURIED CONDUITS

- A. Direct buried conduits shall be installed as described for concrete encased duct banks, with the exception of the concrete encasement.
- B. Where conduit runs parallel the tracks, conduits shall be buried a minimum of 30 inches below finished grade or ballast.

3.05 CONDUIT MARKER TAPE

- A. Conduit marker tape shall be installed over each duct bank or direct buried conduit run approximately 12 inches below finished grade for the full length of each run.

3.06 CABLES

- A. Cables to be installed within the new conduits shall be installed in accordance with Section 16050.

3.07 CLEANUP AND DISPOSAL

- A. Immediately upon completion of all work as required by this Section or any segments thereof, and as directed by the Engineer, remove and dispose of all debris and surplus excavated material away from the site.

PART 4 - MEASUREMENT AND PAYMENT

4.01 GENERAL

- A. The 3-inch PVC conduit supplying power for the busway lighting and the BRT station power and lighting systems shall be paid for under the contract unit price for Item No. 804.3 – 3 Inch Electrical Conduit Type NM – Plastic (UL).
- B. Separate measurement and payment will not be made for all other work required under this Section, complete in place, but all costs in connection therefore, will be included in the Contract Lump Sum Prices for the items of work to which it pertains.

END OF SECTION

SECTION 16450**GROUNDING****PART 1 - GENERAL****1.1 DESCRIPTION OF WORK**

- A. This Section specifies furnishing and installing complete system neutral grounding and equipment grounding in accordance with Standard Specifications Construction, Section 16450, except as modified herein.
- B. Applicable sections and requirements of Section 16050, Basic Materials and Methods for Electrical Work; and Section 16500 Lighting, shall apply to the work furnished and installed under this Section.
- C. The work under this section shall include furnishing all labor, materials, equipment, and services necessary to construct and install the complete electrical grounding connections and system as shown on the Contract plans and specified herein. This shall include all ground wire, ground rods, and incidentals necessary to provide a complete grounding system.

1.2 SUBMITTALS

- A. As-Built Drawings. Submit prior to final acceptance of the work, drawings showing complete layout of systems installed including physical location of ground rods to which connections were made.
- B. Field Quality Control Test Report. Submit reports complying with requirements of Part 3 "Field Quality Control" Article.
- C. Catalog cuts and descriptive literature for materials specified herein and as shown on the Contract Drawings.

PART 2 - PRODUCTS**2.1 BARE GROUND WIRE**

- A. Grounding shall be accomplished in conformance with the relevant provisions of Section 16450. The Contractor shall furnish and install bare copper stranded grounding wire and bond as shown on the plans. A copper clad steel ground rod shall be provided at each lighting pole and control cabinet **as shown on the Contract Drawings**.

2.2 INSULATED GROUND WIRE

- A. Copper, Class B Stranded, 600-Volt, 90 degree C, NEC type THWN; meeting requirements of AAR Specifications No. 535.2; sized as indicated; and UL listed.

2.3 PRODUCTS USED FOR COPPER THERMIT WELDED CONNECTIONS

- A. Use products for copper thermit welded connections which are the products of one manufacturer and are produced for the specific application for which they are used.
- B. Use materials and equipment which meet or exceed the applicable acquirements of the AAR Manual, Electrical Section, Section 13, Chapter 3, Part 6.
- C. Coating Materials for Thermit Welded Connections: Use black, rubber based compound coating materials, which are soft, permanently pliable, moldable, and unbacked, not less than 1/8 inch thick, with properties as follows:

Solids	100 percent
Density	12.0 pounds per gallon minimum
Penetration	90-130 ASTM D5
Water Absorption	0.10 percent maximum ASTM D570
Dielectric Strength	500 volts/mil ASTM D149
Volume Resistivity	2,000 megohms-inches ASTM D257 5,000 megohms-cm ASTM D257
Service Temperature	Minus 40 degrees to 160 degrees F.
Chemical Resistance	Melting point, none; flammability, slow burning (ASTM C653); resists alcohol, water, aqueous hydrochloride and sodium hydroxide; dissolved by carbon tetrachloride, naphtha gasoline, mineral spirits, ketones, and benzene.
Highly cohesive and Adhesive	Adheres strongly to metals and concrete and to itself.

2.4 BOLTED GROUNDING CONNECTORS

- A. For solderless type made of high strength electrical bronze with silicon bronze clamping bolts and hardware; designed such that bolts, nuts, lock washers and similar hardware which might nick or otherwise damage the ground wire will not directly contact the ground wire.

2.5 GROUND RODS

- A. Medium carbon steel core, copper clad by the molten weld casting process; sizes as shown on the Contract Drawings; UL approved.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Perform testing as specified in Part 3 "Field Quality Control" Article.

3.2 GENERAL GROUNDING REQUIREMENTS

- A. General. Provide station electrical grounding complying with procedures of NEC and as indicated.
- B. Equipment Ground Conductors
 - 1. Provide each conduit with equipment ground conductor, colored green.
 - 2. Terminate conductor directly on ground bus for power equipment housing and conduit system; do not connect equipment ground conductor to neutral bus. Additionally, do not use these conductors to carry any line-to-ground loads, such as 240 volt lighting.
 - 3. Provide feeders serving single phase 120/240 volt loads with one equipment ground conductor.
- C. White Neutral Conductor. Provide each conduit feeding line-to-ground loads, such as 120 volt control power with both an equipment ground conductor and insulated white neutral conductor.
- D. For the Power and Communications Shed, provide grounding for the 120/240V distribution panels (total of 2) and communications ground bus.
- E. For the Transformer, Metering Cabinet Power and Communications Shed, provide grounding for the 120/240V disconnect switches, 120/240V distribution panel, and associated equipment.
- F. For the Prefabricated Maintenance Building, provide grounding for the 120/240V distribution panels (total of 2).
- G. Provide convenience outlets having ground fault circuit breakers, complying with Section 16050 – BASIC MATERIALS AND METHODS FOR ELECTRICAL WORK.

3.3 EQUIPMENT GROUNDING

- A. At **each Load Center**, ground system as indicated in contract drawings.
- B. Lighting Fixtures and Equipment .
 - 1. Accomplish grounding with equipment ground.
 - 2. Provide equipment ground conductor electrically and mechanically continuous from system equipment and neutral ground connection at source of supply to equipment to be grounded.
 - 3. Provide copper equipment ground conductor minimum one size smaller than phase conductors, except having minimum size of No. 12 and maximum size No. 4/0 AWG.
 - 4. Identify equipment ground conductors with colored green type THW insulation, except where green insulation is not available on larger sizes, black colored insulation shall be used and suitably identified with green tape at each junction box or device enclosure.
- C. Junction Boxes and Other Enclosures Sized Above Five Square Inches. Securely bond equipment ground conductors to enclosures utilizing equipment ground bus or lug.
- D. Ground Electrodes (Rods)
 - 1. Ground rods shall not protrude above finished grade to prevent a tripping hazard.

E. Grounding Conductors

1. All direct buried grounding conductors comprising of the main ground grid for the new power and communications sheds and control cabinets/enclosures and transformer pads shall be installed a minimum of 30 inches below finished grade or ballast.
2. Separate grounding conductors shall be provided for all circuits as required by these Specifications and as indicated on the Contract Drawings

F. Ground Terminations

1. All ground rod electrical connections should be welded with the CADWELD copper-based exothermic welding process. Exothermic welds shall adhere to manufacturers instructions. Exothermic welds shall be Erico or approved equal

G. Electrical Handole Frames

1. Electrical handhole frames shall be grounded as shown on the Contract Drawings.

H. With each cable run, an equipment ground conductor shall be installed to which all equipment shall be bonded in accordance with standard practice and the NEC. Metal conduit, metal poles and pedestals, metal hardware and lighting fixtures, and metal cabinets shall be made mechanically and electrically secure to form a continuous system and shall be effectively grounded to the ground electrode installed at the service point. Bonding of metallic conduit systems in concrete foundations and pull boxes shall be by means of approved grounding bushings (compatible with the conduit) and bonding jumpers. Green Ground Conductor is always required as an equipment grounding conductor. Rigid steel conduit system may not serve as the equipment grounding conductor.

1. The grounding conductor shall also be bonded to the ground electrode placed at each electric handhole.

3.4 CONVENIENCE OUTLETS

- A. Ground all convenience outlets in accordance with the NEC.

3.5 THERMIT WELDING CONNECTIONS

- A. Connect electrical wires together, to reinforcing steel or soldier piles, as indicated, by thermit welding using the manufacturer's recommended molds and size of charges for application.
- B. Prepare the material to be welded and perform thermit welding in accordance with manufacturer's instructions.
- C. Test completed thermit welds before coating by striking with two pound hammer. If cracks develop, replace welds at no additional expense to the Authority. When required by the Engineer, test the electrical continuity of bonds.
- D. Apply coating so that it extends one inch beyond point of attachment to steel member, overlaps wire coating one inch, and provides insulation thickness equivalent to wire insulation, but not less than 1/8 inch in thickness. Do not apply coating material at ambient temperatures below 20 degrees F or above 125 degrees F. Maintain, by an approved method, curing temperature

SECTION 16500

LIGHTING

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. This Section specifies the furnishing and installing of area lighting systems at various locations, complete as indicated, including walkways, roadways, and BRT Stations, with all lighting fixtures with lamps and ballasts/**drivers**, poles and mounting brackets, hardware, foundations, feeder and branch wiring systems including conduit, wire, splices and terminations, excavation, backfill and compacting for foundations and poles, and conduit systems, hardware and fittings, panel board circuit breakers, power disconnect switches, contactors and control components, wire ways, aerial cable and messenger wire, ground rods, ground wire, ground connectors, clamps and components, and installation of electrical control and protection components, and testing of completed systems.
- B. Applicable sections and requirements of Section 16050, Basic Materials and Methods for Electrical Work; and Section 16450, Grounding; shall apply to the work furnished and installed under this section.
- C. The work under this section shall include furnishing all labor, materials, equipment, and services necessary to construct and install the complete lighting system as shown on the Contract plans and specified herein. This shall include all lighting standards with brackets and foundations, all necessary mounting hardware, light fixtures with luminaires, ballasts/**drivers**, lampholders, lamps, wiring from the feeder to the luminaires connections and all incidentals necessary for a complete area lighting system
- D. The work under this Section shall be performed in conjunction with the relative provisions of Section 820 of the MassDOT Highway Division Standard Specifications for Highways and Bridges, and the Special Provisions contained herein.
- E. The work also includes relocation of existing light poles and appurtenances in the parking lot at 200 Arlington Street, Chelsea, as indicated on the Plans.

1.2 SUBMITTALS

- A. Submit shop drawings, exploded view assembly drawings, catalog cuts, descriptive information for all lighting fixtures, lamps, ballasts, capacitors, ignitors, auxiliary lighting equipment, lighting control equipment, contactors and lighting controls, and mounting hardware for each product type specified..
- B. Submit manufacturer's installation instructions detailing the installation procedures and recommended maintenance procedures that will comply with the warranty specified.
- C. The manufacturer must provide photometric data certified by an Independent Testing Laboratory for each fixture type specified. Data must include the following information:
 - 1. **Luminaires' weight, effective projected area, details of attaching luminaries, accessories, and installation and construction details.**

2. **Manufacturer's recommended replacement parts list.**
 3. **LED Driver/Power Supply: description, operating characteristics, electrical data, component/capacitor temperature rating and reliability testing report from an independent laboratory including mean-time-between-failure (MTBF).**
 4. **LEDs and Printed Circuit Board Construction.**
 5. **LED type, ratings and description including heat dissipation design indicating margin between the maximum rated LED junction temperature and the junction temperature at operating current.**
 6. **Light Loss Factors (lumen depreciation as a function of operating current, temperature and operating hours): Provide measurement bases for these factors.**
 7. **Photometric report illustrating iso-illuminance for the project mounting height, classification type and cutoff characteristic. All photometric files presented shall be prepared and certified by and independent testing laboratory.**
 8. **Independent laboratory IESNA LM-79 and LM-80 Reports.**
 9. **Provide a copy of the 3G vibration test report completed using the procedure defined by ANSI C136.31-2001 American National Standard for Roadway Lighting Equipment – Luminaire Vibration. One exception to the procedure is that only one luminaire may be used during the complete test. All costs associated with the shipping and testing shall be at the contractor's expense. Determination of acceptability will be by the reviewing Engineer.**
 10. **All components shall be submitted with a list of all standards for which the product conforms to.**
 11. **Wiring Diagrams: Power, and control wiring.**
 12. **Coordination drawings including mounting and connection details, drawn to scale, for exterior luminaires, weight of the fixture inclusive of the LED Driver and mounting and installation details drawn to scale illustrating the requirements for the ballast installation in the transformer base**
 13. **Operation and Maintenance Data: For luminaires to include in maintenance manuals**
 14. **Horizontal Illumination diagram for each mounting height specified on the drawings displaying lumens per square foot, ½ Maximum Candela Trace, and the location of the Maximum Candela Trace.**
 15. **Candela Tabulation**
 16. **Coefficients of Utilization and Flux Distribution Analysis**
 17. **Maximum Plane and Maximum Cone of Candela**
 18. **IES formatted photometric data on a compact disk (CD) or digital versatile disk (dvd), prepared by an Independent Testing Laboratory.**
 19. **ISO LUX/Foot candle ISO metric layout for all areas lighting is installed to confirm that the proposed lighting fixtures will meet the lighting design intended layout/foot candle levels as per the contract drawings and specifications.**
 20. **All data submitted must have been prepared within the past five years.**
- D. Pole submittal shall include professional certification that each arrangement (or assembly) conforms to the requirements of this specification before commencement of any manufacturing of product for the project. Certification shall include all apparatus that will be mounted to the poles directly including materials supplied by other trades.
- E. Manufacturer to provide documentation that all fixtures are listed by Underwriters Laboratories, Inc. and state that the fixtures being submitted will operate properly for each mounting condition shown throughout the Contract Drawings.

- F. The manufacturer shall provide for the areas to be illuminated, a computerized printout (in drawing form) detailing the entire finished area(s) on Contract Drawings that are being lighted by the submitted luminaires and a statistical summary of maintained illumination levels at grade by means of a grid spaced no further than five (5) feet on center at a scale of 1"=20'-0" accompanied by a copy of all input data used to create the drawing(s). These calculations shall be reviewed by the Engineer. The manufacturer will be responsible for meeting the criteria regarding minimum and average illumination levels. The Engineer shall be the sole judge as to acceptability.
1. Submit an illumination matrix for the **walkways**, roadway area **and BRT Stations** to represent accurate average footcandles and uniform ratio with a mounting heights, lamp wattage and spacing as shown on the Contract Drawings. The matrix shall be based on luminaires aimed and tilted to provide optimum illumination on the roadway surface, walkways, and **BRT Stations**. Aiming direction and tilt are to be shown for each fixture for guidance in the installation.
 2. Use a maintenance factor of 0.75 for all lighting submittals.
 3. Submit a shop drawing of the lighting contactor including a control component layout, detail of field circuit terminations, a control wiring diagram, and proposed labeling.
- G. The Contractor shall provide signed affidavits from a master electrician who has supervised such electrical installations on a regular basis, stating that the installation is in compliance with the Massachusetts Electrical Code.

1.3 QUALITY ASSURANCE

- A. Fixtures and auxiliary equipment shall be listed, labeled or certified by UL.
- B. Replace lamps/**LEDs**, which fail within 90 days after final acceptance, at no cost to the Owner.
- C. Installation Tolerances: Deviation from location, alignment and mounting height: 1/2 inch noncumulative in any unit or continuous run of fixtures.**
- D. Project/MBTA engineers will take foot candle measurements after lighting installation is completed to confirm the lighting proposed by the contractor shall meet the foot candle levels indicated on the contract drawings and the specifications. The contractor will fix and or adjust at his/her expense any requirements to meet the proposed lighting levels indicated on the contract drawings and the specifications.**
- E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA-70, Article-100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.**
- F. Luminaires, inclusive of the LEDs and LED Driver compartments must be UL-1598 Wet Location listed and IP66 certified.**
- G. The Engineer reserves the right to request that one fixture from the project production lot be sent to a qualified testing facility for testing to confirm the 3G vibration testing data provided as part of the submittal process. As stated, only one luminaire may be used to illustrate conformance with the 3G testing procedure defined by ANSI C136.31-2001 American National Standard for Roadway Lighting Equipment – Luminaire Vibration. All costs associated with the shipping and testing shall be at the contractor's expense. Determination of acceptability will be by the reviewing Engineer.**

H. Luminaires including power supply shall be RoHS compliant and lead/mercury-free.

1.4 COORDINATION

A. Inspect equipment as received. Return for re-placement any equipment damaged in shipment. Equipment shall be stored in a clean, dry, protected area. Retain packing as received from the factory until it is to be installed. Check and seal luminaire openings against rodents and water as necessary.

B. Warranty

The manufacturer shall comply with the following warranty:

1. The manufacturer warrants that the design, material and workmanship incorporated in each luminaire shall be of the highest grade and consistent with established, and generally accepted, standards for lighting application.
2. The manufacturer agrees that this warranty shall commence with the acceptance of the luminaires, whether a defect is patent or latent, and shall continue for a period of five (5) years non-prorated after acceptance by the MBTA.
3. The manufacturer will be allowed to inspect, at no cost to the Authority with the Engineer present, the installation of the product in order for the final issuance of the warranty. Should any modifications be required regarding the installation of the product(s), it will be at the Installing Contractor's expense. Once all modifications are accepted by the manufacturer, the product warranty will become effective and supported by the manufacturer.
4. Any claims against the warranty will be valid regardless of who performs the installation. The manufacturer will be allowed to inspect after the time the repair has been made, at no cost to the Authority with the Engineer present, the installation of the product in order for the final issuance of the warranty.

1.5 REFERENCE STANDARDS

A. American National Standards Institute (ANSI) Publications

1. **C62.41 - Characterization of Surges in Low-Voltage (1000V and Less) AC Power Circuits**
2. **C78.377 - Specifications for the Chromaticity of Solid State Lighting Products**
3. **C82.SSL-1 - Operational Characteristics and Electrical Safety of SSL Power Supplies and Drivers**
4. **C83.77 - Harmonic Emission Limits – Related Power Quality Requirements for Lighting**
5. **C136.2 - Roadway and Area Lighting Equipment-Luminaire Voltage Classifications**
6. **C136-10 - Standard for Roadway Lighting Equipment, Locking-Type Photo control Devices**
7. **C136-14 - Standard for Roadway Lighting, Enclosed Side-Mounted Luminaires for Horizontal Burning High Intensity Discharge Lamps**
8. **C136-22 - Standard for Roadway Lighting, Internal Labeling of Luminaires**

9. **C136-31 - Standard for Roadway Lighting Equipment Luminaire Vibration**
- B. American Society for Testing and Materials (ASTM) Publications:**
 1. **B117-03 - Standard Practice for Operating Salt Spray (Fog) Apparatus**
 2. **D522-93a - Standard Test Methods for Mandrel Bend Test of Attached Organic Coatings**
 3. **D714-87(94) - Standard Test Method for Evaluating Degree of Blistering of Paints**
 4. **D1654-92 - Standard Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments**
 5. **D3359-97 - Standard Test Methods for Measuring Adhesion by Tape Test**
 6. **G7-05 - Standard Practice for Atmospheric Environmental Exposure Testing of Nonmetallic Materials: Testing for UV resistance**
- C. International Electro-technical Commission (IEC):**
 1. **IEC 60598 - Degrees of Protection provided by Enclosures (IP Code)**
- D. American Association of State Highway and Transportation Officials (AASHTO):**
 1. **Roadway Listing Design Guide – October 2005**
 2. **Techniques of Lighting Design**
 3. **Illuminance and Luminance Design Values (English)**
- E. National Fire Protection Association (NFPA) Publications:**
 1. **70 - National Electrical Code**
 2. **502 - Standards for Road Tunnels, Bridges, and Other Limited Access Highways, 204**
- F. National Electrical Manufacturers Association (NEMA):**
 1. **250 - Enclosures for Electrical Equipment**
- G. Underwriter's Laboratories Inc. (UL) Publications:**
 1. **467 - Grounding and Bonding Equipment**
 2. **1029 - High Intensity Discharge Lamp Ballasts**
 3. **1598 - Standard for Luminaires**
 4. **8750 - Light-Emitting Diode (LED) Equipment for Use in Lighting Products**
 5. **IEUR - Guide Information for Luminaire Poles**

1.6 PRODUCT DELIVERY, STORAGE & HANDLING

- A. The Manufacturer is required to ship the lighting fixtures, poles, and accessories securely packaged and labeled for safe handling during shipment to avoid damage or distortion.

- B. The Contractor is responsible for storing lighting fixtures, poles and accessories in a secure and dry facility and in original packaging to prevent soiling, physical damage, wetting or corrosion prior to installation.
- C. Contractor must provide for storage inspection by the Engineer after fixtures have been delivered.

1.7 DESCRIPTION OF ILLUMINATION

- A. Roadways **(including the Busway)** and walkways shall be illuminated to a maintained minimum horizontal footcandle level of **four (4)** footcandles with an average/minimum footcandle uniformity ratio of 4:1 or better at the roadway and walkway surfaces.
- B. **The Shared Use Path shall be illuminated to a maintained minimum horizontal footcandle level of two (2) footcandles with an average/minimum footcandle uniformity ratio of 4:1 or better at the path surfaces**
- C. The Bus Rapid Transit Station platform and waiting areas shall be illuminated to a maintained minimum horizontal footcandle level of Twenty (20) footcandles with an average/minimum footcandle uniformity ratio of 4:1 or better at the station waiting area surface.

PART 2 - PRODUCTS

2.1 LIGHTING FIXTURES

A. General Requirements

1. Provide lighting fixtures, complete and ready for service, in compliance with UL 57, of the number, type, material, finish, electrical components and characteristics, and with all necessary hardware and auxiliary equipment indicated.
2. The fixtures shall be clearly marked with manufacturer's name and catalog number, voltage, acceptable lamp type, maximum wattage, ballast/**driver** type, and self-protection, if any. The fixtures shall be identified with standard lamp type and wattage on the exterior of the fixture housing visible from ground level. Two-inch adhesive labels with a number indicating wattage and color signifying lamp type shall be provided.
3. Fixtures shall be rain-tight and dust-tight for use along trackways, for outdoor use, and as indicated. Fixtures must meet IP55 test for water and dust.
4. Fixtures shall be of the same design shape and supplied by the same manufacturer. Luminaires for the project are broken down as follows:
 - a. The Busway will use 100 watt light emitting diode (LED) luminaires
 - b. Sidewalks and the Shared Use Path will use 100 watt LED luminaires
 - c. BRT Station Canopies will use **LED** luminaires with a fixture (housing) dimension as shown on the contract drawings. Canopy fixtures are to be UL approved for raintight use.
 - d. Abutment mount fixtures will use LED wall pack with a fixture (housing) dimension measuring approximately 9" x 18" x 10".
5. Performance Criteria

- a. Luminaire shall be UL and CUL listed for wet locations.
 - b. Housing Size shall be rectangular **or as indicated otherwise.**
 - c. Lamp Type shall be **LED** suitable for horizontal and vertical mounting.
 - d. Voltage shall be Multi-voltage (120 through 480) and which includes operation suitable for 480 volts.
 - e. Beam pattern shall be IES Type Distribution
 - f. Mounting arms and brackets shall be as shown on Contract Drawings.
 - g. Color shall be Silver Natural Aluminum **unless otherwise indicated.**
 - h. Double fusing shall be provided **if available.**
 - i. Fixture shall consist of mounting, optical, support, and electrical systems.
 - j. Housing shall be one piece formed aluminum with smooth welded seams.
 - k. Lens shall be minimum 1/8 inch thick clear tempered flat glass attached to the door frame.
 - l. Exterior surface finish shall be a fade resistant silver natural aluminum polyester power paint baked on to provide a hard durable coating **unless otherwise indicated.**
 - m. Optical system shall provide a fully reflective interior constructed of an enhanced pre-anodized aluminum.
 - n. The electrical system shall consist of ballast/**driver** and components attached to a **circuit board**. The **circuit board** shall be removable without the use of tools. Ballast factor shall be 1.0
6. Finishes of fixtures shall be silver natural aluminum **unless otherwise indicated.** Thermoset Polyester Powder-Coat 2.5 Mil nominal thickness paint applied over a chromate conversion coating.
 7. Fixtures shall have tool-less quick disconnects for electrical assembly or tool-lessly removable **circuit board** to allow ease of maintenance.
 8. Lighting Poles shall be 6" square aluminum as shown on the Contract Drawings.

B. Materials

1. Thicknesses, gauges and tempers of products: indicated, and as recommended by the manufacturer for the specific finish, proper forming operations and structural requirements.
2. Lighting sheet for reflector material: Prefinished aluminum, minimum thickness 0.032 inch, architectural Type 1 with Class M1, anodic coating providing 83% reflectively.
3. Concrete for base foundations: Section **820 of the MassDOT Highway Division Standard Specifications for Highways and Bridges, and the Special Provisions.**
4. Acrylic lenses: 100% virgin acrylic plastic.
5. Polycarbonate lenses and diffusers: Injection molded, crystal clear material, polycarbonate.
6. Lenses to be clipped and hinged.

C. Finishes

1. Finishes shall be in accordance with the manufacturer's recommendations for the specific application.
2. Commence no finishing operations until fabrication and forming operations have been completed.
3. Aluminum work to be anodized shall be given a preanodic treatment followed by an architectural Class 1, anodic coating as described by the Aluminum Association.

- a. Anodize aluminum in accordance with procedures established by alloy manufacturer to achieve color within specified range.
- b. Apply a clear organic protective coating to exposed aluminum surfaces that may experience prolonged contact with caustic material, i.e., concrete, plaster.
- 4. Baked enamel: Factory applied to clean surfaces prepared with a chromate conversion coating, and prime coating, as indicated.
- 5. Porcelain enamel coating: In accordance with the requirements of Porcelain Enamel Institute, PEI-S-100.
- 6. Galvanized coating: Hot-dip galvanized or hot-zinc conforming to ASTM A 386. Where painting of the galvanized surface is indicated, prepare the surface with vinyl acid wash primer with polyvinyl butyral resin 56 pounds, 80 gallons zinc chromate pigment and phosphoric acid.

D. Electrical Components

1. LED Driver

- a. **LED drivers used in the luminaires shall be of the luminaire manufacturer's specification, subject to the same operating requirements, quality assurance program and terms of warranty as the luminaire.**
- b. **Type: Switching-type with constant current output; commercial grade with a capacitor life rating of 70,000 hours or better at 63 Deg. C case temperature. Other components with limited shelf life or subject to degradation over time shall not be used on the driver circuit board rated minimum operating life for the driver shall not be less than the operating life of the overall LED package measured to 24% depreciation of initial lumen output.**
- c. **Input Voltage: LED drivers designed for multi-voltage input (120-277V) or (347-480V). 50-60Hz. shall automatically select for the connected voltage or shall be clearly marked at the point of connection for the particular voltage.**
- d. **Drivers shall be overload/overcurrent protected on the AC line side connection preferably with an electronic resettable device or a fuse; fuses shall be protected in tool-less, finger-safe holders and shall be replaceable without removing incoming power.**
- e. **A shielded and replaceable surge protective device (rated ANSI C62.41 Category C) shall be provided integral with the luminaire/driver package to dissipate transient voltages appearing on the AC input.**
- f. **The LED optics package shall be designed to meet the lighting requirements as specified herein with a drive current no greater than 600mA but shall be designed and capable of continuous operation within allowable temperature limits to meet the application requirements.**
- g. **Operating Temperature Range: (-)40 to (+)40 deg. C.**
- h. **The minimum MTBF shall be one million hours in accordance with Telcordia SR-322 per-formed by an independent laboratory at the operating current required by the application and at the maximum rating of the driver.**
- i. **LED driver efficiency shall be 90% or higher with power factor greater than 90% at any drive current.**
- j. **LED driver shall in compliance with FCC 47 CFR Part 15..**

2. LEDs

- a. **Optics package: Consisting of one or more LED modules or 'light bars' each comprised of multiple LED's. The number of LED modules used shall be based on the required lumen out-put to achieve the project illumination design goals defined in field quality control. The op-tics package with the**

required number of light bars shall also be rated with the housing for 3G vibration. The optics package (light bars) shall be rated IP66.

- b. **Operating Temperature Range:** (-)40 to (+)40 deg. C.
- c. **Manufacturers of LED's shall have been in the business for 15+ years, engaged in research, development and marketing of LED wafers and shall have patents on these and related products. Qualified manufacturers of LED's include: NICHIA, CREE or equal.**
- d. **LED's used by the luminaire manufacturer shall be identified and direct-sourced from the manufacturer of the LED and shall be certified by the manufacturer of the luminaire as being the LED type and rating used in the manufacture and design of the photometric and thermal characteristics of the particular luminaire.**
- e. **LED's shall be color matched for all light bars on any given luminaire to a Correlated Color Temperature (CCT) of 5000K with CRI of 70.**
- f. **Consisting of one or more LED modules or 'light bars' each comprised of multiple LED's connected such that individual LED failures may occur without affecting any other LED's in the column and row where the failed LED occurred.**
- g. **Quality control checks, specifications and binning procedures used by the manufacturer of the luminaire shall be submitted along with the luminaire specification sheets and shop drawings.**
- h. **Light Loss Factor: calculated at 15 years (minimum 11 hours of operation each day) combining Light Lumen Depreciation (LLD) calculated at the maximum operating junction temperature, the Luminaire Dirt Depreciation (LDD) and an efficiency factor relating power supply degradation to light loss shall be greater than 22.5 percent.**
- i. **LED maximum rated junction temperature: The overall design of the thermal package shall provide a temperature margin when operating at the maximum rated driver current in a 40°C ambient temperature not to exceed the maximum allowable LED junction temperature.**

3. **Fixture Wiring**

- a. **Fixture Wires:** Outdoor rated, Stranded tinned-copper construction, not smaller than No. 16 AWG. Insulation: silicone rubber type SF-2 and 200°C rated. Conductor size, temperature rating, voltage rating and manufacturer clearly marked on the insulation of each conductor.
- b. **Use wires between lampholders and associated operating and starting equipment of the same ampacity rating as leads from the ballast. Wiring within the fixtures shall conform to the requirements of the NEC.**
- c. **Tape wires at all points of abrasion. No splices shall be permitted within fixtures other than as required to connect.**
- d. **Fixture Grounding.** Unless otherwise specified, the housing of each ballast/**drivers** lighting fixture shall be provided with a separate, factory-installed grounding device. The grounding device is to be used for connecting a separate, green, grounding conductor to the fixture housing.
- e. **Wireways and wiring channels shall have rounded edges or bushed holes wherever conductors pass through. Insulated bushings shall be installed at points of entrance and exit of wiring.**

E. **Fixture Hardware**

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1. Latch and release mechanism, hinges, pins and other retaining parts of fixtures; screws, bolts or other assembly and mounting parts: manufactured of Type 316 stainless steel. All springs: heavy duty stainless steel. All retaining hardware: self-retaining.
2. Frame light transmitting elements of the fixture to permit replacement of panels in the frames without the use of tools other than screwdriver or pliers. Secure panels in the frames in a neat, rattle-free manner that will provide proper tolerance for normal expansion and contraction.
3. Provide stems for all pendant mounted fixtures of length as required for the specified mounting height with swivel hangers or ball aligners as required.
4. Form gaskets, sealants and adhesives subjected to high temperature from silicone rubber. Provide other gaskets of neoprene, or as indicated.
5. Fasteners: Provide bolts, nuts, washers, screws, nails, rivets and other fastenings necessary for proper erection or assembly of work. When exposed to the atmosphere, provide fasteners made of 18-8 stainless steel. Fasteners within the housing shall be made of zinc plated, bright iridite, steel or electrogalvanized, gray. Nuts shall have captive externally footed lockwashers.

F. Welding

1. Locate welds in assemblies to be anodized to conceal visible discoloration in the heat-affected zone.
2. Where weld metal will be exposed after anodizing, select filler alloys to closely match composition of base metal. Comply with parent metal manufacturer's recommendations for such filler alloys.

2.2 **FIXTURE MOUNTING HARDWARE**

- A. General Requirements. Provide the fixtures with brackets, straps, canopies and stems, poles and miscellaneous hardware outdoor rated and suitable for the mounting method specified.
- B. Secure mounting brackets to housing, quantity and spacing as indicated. When exposed to public view, fabricate and finish hardware in matching material to fixture body. Fabricate internal brackets from sheet steel, zinc coated after fabrication.
- C. Canopies, holders and similar parts shall be drawn or spun in one piece with a minimum 0.026 inch finished thickness.
- D. Tubing used for supporting member shall be seamless drawn with a minimum of 1/16 inch wall thickness of size and length as indicated.
- E. Light poles: Of the type, configuration and dimensions, indicated. The pole shall resist wind loads of 90 mph with a maximum deflection of five percent when fully loaded by their own weight, weight and wind resistance of luminaires they support, and any externally applied loads. Furnish poles as indicated with four by six inch handhole with flushcover, luminaire mounting (tenon/bracket), base cover and all mounting hardware including anchor bolts, nuts, washers and baseplate to permit accurate alignment and installation of pole and luminaire as indicated. All wiring splices to be located above ground. All exterior light poles to have a minimum 24 inch concrete base for protection from snow plows.
- F. General Requirements:
 1. Poles shall be **aluminum** as shown on Contract Drawings.

2. Poles shall meet the latest AASHTO Standards for Highway Signs, Luminaires and Traffic Signals for a wind speed of 90 MPH.
3. Poles shall be provided with mounting brackets suitable for mounting the number and Type of fixtures specified at each pole location. Bracket shall be galvanized steel.
4. Wiring shall be by aerial cable as shown on Contract Drawings.
5. The pole manufacturer and/ or Professional Engineer shall provide complete design wind calculations with consideration for snow and ice loading, along with the shop drawing submittals. The poles shall be approved by the Engineer prior to ordering. All shop drawings shall be stamped by a Professional Engineer registered in the Commonwealth of Massachusetts. Calculations shall be provided for new lighting poles, with new lighting fixtures and new aerial cable installed. Calculations shall be provided for existing poles with new aerial cable added. Refer to Contract Drawings

2.3 LAMPS

- A. General Requirements. Provide each lighting fixture with the number, type, and wattage of lamps required by the Contract Drawings. Provide lamps of standard manufacture, readily available, and of the highest efficiency and life consistent with other requirements of the illumination system.

2.4 AUXILIARY LIGHTING EQUIPMENT

- A. General Requirements. Auxiliary lighting equipment intended to supply illumination in the event of failure of normal power supply: Conform to the applicable requirements of UL924, NEC, MBTA Life Safety Code, NFPA-101, Massachusetts State Building Code, and the Massachusetts Electrical Code.
- B. Utilized battery packs mounted integral with fluorescent fixtures shall energize upon failure of normal power and shall provide approximately the constant light output delivered under normal power operation, for a period not less than 90 minutes. The unit shall contain a transistorized inverter ballast, a transfer relay and associated circuitry, a battery charger and batteries of nickel-cadmium. In addition, a test button and derangements signal light shall be provided to monitor the charging function.
- C. Battery packs mounted remote from luminaires: Conform to the applicable requirements of UL 924. The battery-powered source shall provide continuous power to lighting loads, consisting of any mix of HID, fluorescent, or incandescent lamps. During short power interruptions, brownout conditions or a total lapse of normal AC power, it shall supply the full rated load at both 120 and 277 volts for ninety minutes to a minimum voltage level of 87-1/2% of nominal voltage.

2.5 LIGHTING CONTROL EQUIPMENT

- A. General Requirements. Provide lighting control components suitable for the lighting system specified and compatible for interface with other associated control devices. Lighting control components shall be rated for continuous service and operate satisfactorily in every respect while the branch circuit power supply voltage to each system is within a 105 to 130 volt range at 60 hertz. Electrical contacts shall have precious metal surfaces.

B. Lighting Contactors

1. Conform to the applicable requirements of UL 508.
2. Contactors shall be two pole mechanically held, electrically operated lighting contactors enclosed in a NEMA 1 enclosure. The contactor shall be supplied with a "hand-off-auto" selector switch, a fused control circuit, a two-pole relay which will allow the use of one pole photoelectric and time clock controls. The contactor shall be supplied with coil clearing contacts which will de-energize the coils if the control device is non-momentary. The contactors shall have current ratings as called for on the drawings.
3. The photo control shall have a turn on range of from .5 to 2.5 footcandles with a turn off level between 1 and 5 footcandles (minimum) higher. A time delay feature shall be incorporated as a part of the control circuit to prevent turn offs by stray transient light.
4. Acceptable for operations at 120V nominal, single-phased transient 60HZ.
5. Rated for pilot control circuit operation, 10A at 120 VAC.

C. Lighting Relays

1. Conform to the applicable requirement of UL 508.
2. Electrically operated and mechanically held.
3. Rated at 600 volts, 60 hertz, 25 amperes with number of poles and enclosure as indicated.

D. Time Switches

1. Conform to the applicable requirements of UL 887.
2. Pre-wired with astronomic dial, 36-hour synchronous reserve power motor.
3. Manual on-auto-off bypass switches for up to three individual circuits.
4. Rated at 240 volts (minimum), 60 hertz, 40 amperes continuous duty with number of poles, throws and enclosure as rated.

E. Photoelectric Sensor

1. Conform to the applicable requirements of UL 773.
2. Operation in temperature range of minus 50°C to plus 60°C.
3. Dusk to dawn operation with adjustments from two to 50 foot candles with a five-second time delay to preclude false switching.
4. Weatherproof and tamperproof.
5. Acceptable for operation from a supply voltage range of 105 to 285 volts AC.
6. Rated for a lamp load of 1000 watts of incandescent lighting; 1800 va of mercury vapor, fluorescent, or high-pressure sodium lighting.
7. Minimum life at rated load: 8000 on-off operations.
8. Provided with three blade, twist lock polarized plug and receptacle.
9. Photoelectric sensors shall be mounted facing a northerly direction.
10. 1Photoelectric sensors, upon failure, shall default to the "on lighting" position.

F. Light Intensity Controls

1. Enclosed, automatic or manually, continuously-adjustable, and completely solid state for the control voltage and rated load indicted.
2. Incandescent systems.
3. Fluorescent systems.
4. HID systems.

G. Wall Switches

1. Fed. Spec. W-S-896, types II and III. Switches installed in hazardous areas: Explosion-proof type in accordance with the NEC and as indicated.
2. Switches: Single unit, toggle, butt contact, quiet type with an integral mounting strap.
3. Wall switches for remote control: Momentary contact type suitable for mounting in a single gang outlet box space and compatible with standard design wall plates.
4. Switch Ratings
 - a. For 120 volt circuits: 20 amperes at 120 volts AC.
5. Switches shall be connected to the wiring with screw clamp type terminals.
6. Wall Plates
 - a. Type 304 stainless steel
 - b. Standard designs so the products of different manufacturers will be interchangeable.
 - c. Where switches are mounted adjacent to each other, the plates shall be common for each of the groups of switches.
7. Incorporate barriers between switches within multigang outlet boxes where required by the NEC.

H. Controls

1. The controls will allow automatic control of the lighting system and will provide on-off control of the lighting in response to two modes of operation.
 - a. Manual
 - b. Automatic

In the automatic mode, the primary control device shall be the photocell. However, the time clock will be wired into the control circuit such that the light may be turned off for a preset period of time during the normal photocell "on period." This time clock controlled "off" period shall be completely programmable for periods of time as short as 15 minutes and the settings shall be visible on the face of the time clock. The time clock shall be electrical mechanical type with adjustable trip dogs. Astronomical electronic time switch shall not be used.

I. Key Switch

1. The key switch shall be a heavy duty oil tight 3 position selector switch rated 10 amperes at 120 VAC.

PART 3 - EXECUTION

3.1 LIGHTING FIXTURES

- A. Install lighting fixtures in accordance with the manufacturer's instructions, complete with lamps, hangers, brackets, poles, fittings, and accessories, ready for operation as indicated. Align, mount and level the lighting fixtures uniformly.
- B. Avoid interference with and provide clearance for equipment. Where the indicated locations for the lighting fixtures conflict with the locations for equipment, change the locations for the lighting fixtures by the minimum distances necessary as approved by the Engineer. There are some locations where installation of poles, luminaires, and conduit system will cause interference with Rail Right of Way and Rail facilities. In these instances, the Contractor shall call attention to the fact that, these interferences will take place and will work with Rail

Operator and the Engineer to assure corrections are made so as not to delay the construction schedule.

- C. For suspended lighting fixtures, the mounting heights shall provide the clearances between the bottoms of the fixtures and the finished floors as indicated. Chains shall not be used for suspension of fixtures.
- D. Lighting fixture supports shall provide support for all the fixtures. Anchor supports to the structural slab or to structural members as indicated. Supports shall maintain the fixture positions after cleaning and relamping.
- E. Surface mounted lighting fixtures shall be bracketed rigidly from the mounting surfaces. Provide a 1/4-inch clearance between surfaces when the fixture is flat mounted against concrete surfaces. Nipples carrying wire between fixtures shall be watertight.
- F. Exterior fixtures mounted on block or brick walls shall be supporting anchor devices of the expansive lead type. No power driven anchors will be acceptable.
- G. Where aluminum is placed in contact with dissimilar materials, except galvanized steel, zinc or stainless steel, treat contact surfaces as follows:
 - 1. When in contact with dissimilar metals, apply a prime coat of zinc chromate primer followed by two coats of aluminum and masonry paint.
 - 2. When in contact with concrete, masonry and plaster, apply to aluminum contact surfaces zinc chromate primer, bituminous paint, aluminum metal and masonry paint or pressure tape.
 - 3. When in contact with wood or other absorptive materials, apply two coats of aluminum house paint to such materials and protect aluminum contact surfaces with bituminous paint.
- H. Provide pendant fixtures with swivel hangers to assure a plumb installation and have a minimum 25° swing from horizontal in all directions. Single unit suspended fluorescent fixtures shall have twin stem hangers. Multiple unit or continuous units shall have a tubing or stem for wiring at one point and tubing provided for each unit length of chassis including one at each end. Tubing shall not be less than 3/16 inch in diameter. Motion of swivels or hinged joints shall not cause sharp bends in conductors or damage to insulation. For heavy pendant mounted fixtures, where support independent of box is required and where conduit and outlet boxes are installed on surface, provide safety swivel hangers with fixture studs.
- I. Install fixtures to be pole mounted in accordance with the manufacturer's recommended installation practices as indicated.
- J. Provide required lamps in each lighting fixture as soon as fixtures are properly installed.
- K. Light meter readings shall be taken at night to insure proper aiming of the fixtures. The Contractor shall provide men and equipment to make any required field adjustments at this time. The Engineer shall have the right to witness illumination measurements. See Contract Drawings.

3.2 BALLASTS/DRIVERS

- A. Install ballasts/**drivers**, other than those mounted integrally within luminaires, as indicated, and in such a manner that the ballast is protected from weather, moisture, and other atmospheric conditions, and in such a manner that ambient temperature surrounding the ballast/**driver** will not cause the temperature of the ballast/**driver** housing hot spot to exceed UL requirements. Voltage drop to lamp, due to remote mounting shall not exceed one percent of the nominal lamp voltage.

3.3 LIGHT POLES

- A. Install light poles in accordance with the manufacturer's recommended installation practices as indicated.

3.4 CONCRETE BASES

- A. Obtain necessary templates and anchor kits before starting work. Construct bases in accordance with details shown on the plans.

3.5 AUXILIARY LIGHTING EQUIPMENT

- A. Install as indicated and in accordance with manufacturer's instructions.
- B. Anchor firmly in place.
- C. Test and adjust for proper operation in accordance with the manufacturer's instructions.

3.6 LIGHTING CONTROL DEVICES

- A. Install lighting control devices in accordance with the manufacturer's recommended installation practices, and as indicated.
- B. Where indicated, incorporate the components in panelboards behind separate doors and mount them on sound absorbing materials.
- C. Install circuit breaker or fuse protection for the control circuits.
- D. Mount the switches on the strike plate side of the doors.
- E. The contactor and control relay shall be incorporated into one NEMA 1 enclosure mounted inside the **Load Centers**.
- F. All control components shall be neatly labeled or stenciled as to the identification and purpose of the component (i.e., "Contactor C1," "Time Switch TS1," "Key Switch KS1", etc.).
- G. The Contractor shall initially set the time clock so that its control position is closed from 5:00 P.M. through 1:00 A.M. and opened 1:00 A.M. through 4:00 A.M.

- H. As-built copy of the component arrangements and wiring of the lighting controls shall be placed in a plastic envelope inside the lighting panelboard. A copy shall be included in the as-built record for the project.
- I. The photoelectric controls shall be mounted on the **inside** wall of the **Load Center**. The photo control wiring shall be minimum No. 10 AWG. The photo control shall provide pilot control for the lighting contactors and shall not have any direct connections to any luminaires.

3.7 FIELD QUALITY CONTROL AND INSPECTION

- A. Inspect luminaires, lamps and associated hardware prior to and after installation to confirm that they are of the quality and type as specified herein and as indicated, and are free of defects and damage.
- B. Provide luminaires and lighting equipment to the project site complete, with suspension accessories, canopies, hickey, castings, sockets, holders, reflectors, ballasts, diffusing materials, louvers, frames, recessing boxes, and related items, completely wired and assembled as indicated.
- C. Whenever practicable, test lighting systems at the same time that the distribution panelboard or switchboard is tested.
- D. Adjust **lighting fixtures** in accordance with the aiming chart provided by the manufacturer. Make adjustments during darkness to obtain the optimum lighting levels throughout.
- E. After satisfactory completion of the specified installation, the illumination system shall be placed in operation. Final acceptance will not be made until the system has operated satisfactorily for a period of not less than 30 days from a date designated by the Engineer. This test period shall be included within the specified contract time. Operation of the system shall not in any way be construed as an acceptance of the system or any part of it or as a waiver of any of the provisions of this contract. The Contractor shall be responsible for the system during this period of operation and he shall make any adjustments or repairs which may be required and remedy defects or damages which may occur, at his own expense. The Contractor will not be required to pay for electrical energy consumed by the system during this trial operation.

PART 4 - MEASUREMENT AND PAYMENT

4.1 GENERAL

- A. Separate measurement and payment will not be made for work under this section, but all costs in connection therefore, for furnishing and installing lighting systems along the BRT Stations, the Silver Line Busway, and the Shared Use Path, including luminaires, mounting hardware, conduits, wires, handholes, light poles, and all other incidentals necessary to complete the item, including coordination with the applicable electric company, shall be included in the Contract Lump Sum Price for Item No. 745.01 – Bus Rapid Transit Station, and the Contract Lump Sum Price for Item No. 820.10 – Highway Lighting - Roadway.

SECTION 16700

POWER WIRE AND CABLE

PART 1 - GENERAL

1.01 DESCRIPTION

- ③ A. This Section specifies furnishing and installing power wire and cable for the AC power distribution system of the Chelsea Silverline Bus Rapid Transit Stations.

1.02 QUALITY ASSURANCE

- A. Material and workmanship shall be of the highest quality assuring durability for minimum life expectancy of 40 years. These cables shall be suitable for use in the environment to be encountered on a railroad system, and underground distribution system. The cables shall also be certified for continuous operation at 90 degrees C in wet or dry locations with no conductor failing in continuity or with loss of insulation to cross or ground less than one (1) meg-ohm.
- B. Qualification
1. All wire and cable manufacturers must be approved by the Engineer. The Contractor shall provide all data required for the Engineer's evaluation and shall make the arrangements for any required demonstrations and tests.
 2. Qualifications shall be based on the following criteria:
 - a. Past Performance and Experience. The cable manufacturer(s) must demonstrate previous successful experience in supplying cable to the railroad industry for use as AC power cables. A list of such installations shall be provided for each cable manufacturer to be considered.
 - b. Quality Assurance Program. The manufacturer(s) of cables, in accordance with the requirements of these Specifications, shall be accomplished in compliance with a Quality Assurance Program that meets the intent of the ASQC Standard CI-1968, General Requirements for a Quality Program. Such compliance shall promote a thoroughly tested cable, which will render long service life to the user. Prime concern must be focused on the necessary formal assurance requirements to insure that cable failure cannot be attributed to actions or lack of actions by the manufacturer.
 - c. Technical Data. The Contractor shall provide full technical data, which demonstrates compliance with the requirements of these Specifications for each specified cable type the Contractor plans to supply.
 - d. Demonstration Tests. The Contractor shall make arrangements with the prospective cable manufacturer(s) to perform demonstration tests as required by the Engineer.
 - e. Sample Specimens. The Contractor shall, if requested by the Authority, furnish to the Engineer within 20 days after the Notice-to-Proceed,

sample specimens in four (4) foot lengths similar to that which the manufacturer(s) proposes to furnish for each type cable specified herein. The sample specimens shall remain the property of the Authority.

f. The manufacturer(s) shall certify that he shall comply with the following warranty prior to selection:

1. The manufacturer(s) warrants that the design, material, and workmanship incorporated in each item of cable shall be of the highest grade and consistent with the established, and generally accepted, standards for aerial and underground cable for ac power circuits; and that each such item and every part and component thereof shall comply with these Specifications.
2. The manufacturer(s) agrees that this warranty shall commence with the acceptance of each item of the cable, whether the defect be patent or latent, and shall continue for a period of two (2) years after initial satisfactory operation of the item or four (4) years after acceptance of the item, whichever is shorter.
3. The warranty covering any length of cable that shall be replaced by the manufacturer(s) under the above conditions shall be reinstated for a period of two (2) years effective as of the day when said replacement is affected. If the failure is found to be of major importance and affects any other item of cable, the reinstatement of the warranty shall then be extended to cover the item so affected as well, and shall start as of the date of such replacement. The warranty reinstatement provided for in this subparagraph 3 shall apply only to the first replacement or repair of any such item and, in the case of failure of major importance, to the first extension of the said warranty to said affected items.
4. The foregoing warranties are exclusive and in lieu of all other warranties written, oral, implied, or statutory (except as to title and freedom from lien). In no event shall the manufacturer be liable by reason of breach of warranty for special or consequential damages.

C. After Selection

1. The Contractor shall monitor the manufacturer(s) of the wire and cable to assure that the approved Quality Assurance Program is being closely adhered to and that the wire and cable is being manufactured in accordance with these Specifications and the approved submittals.
2. Each finished wire and cable shall be traceable to the test date on file for each step in its manufacturing process.
3. Inspection

SECTION 16850

ELECTRIC HEATING EQUIPMENT

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Work Included:** This Section specifies furnishing, installing, connecting, testing, and placing in operation Electrical Infrared Heating devices and equipment at the Bus Rapid Transit (BRT) Stations as indicated on the Drawings.
- B.** The electric infrared heaters shall be self-contained factory assembled, and UL listed and including the heating element, reflector, heater housing, mounting brackets, element holders, wire guards, and high-temperature internal wiring. Performance, controls and accessories shall be as indicated on the Drawings.

1.2 SUBMITTALS

- A. Submit the following to the Engineer for approval:**
 - 1.** Catalog cuts of all standard cataloged equipment.
 - 2.** Heater layout drawings;
 - 3.** Wiring diagrams for heating systems;
 - 4.** Heater and control equipment installation details;
 - 5.** Heat pattern coverages; and
 - 6.** Factory test reports.

PART 2 - PRODUCTS

2.1 INFRARED HEATERS

- A. Heating Element:** Quartz tube or metal sheath with coiled resistor wire.
- B. Heater Housings:** Stainless Steel construction. Provide a stainless-steel wire guard to prevent heating elements from accidental damage.
- C. Reflectors:** Polished stainless steel.
- D. Wiring:** Fully enclosed internal wiring. Provide minimum 6 inch slack fixture (heater) wire for connection to branch circuit wiring.

2.2 CONTROL PANEL

- A.** For each bus stop heated enclosure, provide a lockable NEMA 1 or NEMA 4 Control Panel with disconnect switch, contactor, fusing, 24 volt control circuit, heater on/off timer switch, and pilot light indicating heater on.

- B. Timer switch shall be 0 to 10 minutes minimum, 0 to 20 minutes maximum range. All heaters within one bus stop enclosure shall be controlled by one control panel. Provide a remote ADA vandal-resistant “ON” button, and a remote ADA vandal-resistant “OFF” button. Both buttons shall be corrosion-resistant metal and minimum 2” diameter. The remote “ON” button will be pushed to energize the heaters for the set time of the timer inside the control panel (timer set by the installer). The “OFF” button will be pushed to turn off the heaters if necessary before the timer turns off the heaters.

PART 3 - EXECUTION

3.1 INFRARED HEATERS

- A. Mount infrared heaters with standard adjustable mounting bracket positioned as indicated on the drawings.
- B. Provide minimum clearances per manufacturer recommendations.
- C. Heat pattern coverage shall be compatible with bus shelter heated enclosure layout.

3.2 CONTROL PANEL

- A. Mount each control panel inside a locked NEMA 4 metal box located where indicated at each bus stop heated enclosure. The remote “ON” and “OFF” buttons will be connected to the heater manufacturer’s control panel via field wiring and conduit.

PART 4 - MEASUREMENT AND PAYMENT

4.1 GENERAL

- A. Separate Measurement and Payment will not be made for work required under this Section, but all costs in connection, therefore, will be included in the Contract Lump Sum Price for Item No. 745.01 – Bus Rapid Transit Stations. The lump sum price shall include all materials, labor, tools and equipment incidental and necessary for the installation, complete in place, of the Electric Infrared Heaters.

END OF SECTION

CONSTRUCTION SPECIFICATIONS

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1.06 REPAIRING AND REPLACING EXISTING WORK

- A. The Contractor shall work through the Engineer to obtain the necessary coordination with the Operation and Maintenance Departments of the Authority in order to permit construction progress with the most possible cooperation. MBTA commuter service shall be maintained uninterrupted. Furthermore, the Contractor shall coordinate his efforts with other Contractors working on separate contracts in the immediate vicinity of the construction sites.

1.07 WARRANTY OF WORK

- A. Neither final acceptance, final payment nor any provision in the Contract Documents nor partial or entire use or occupancy of the premises by the Authority shall constitute an acceptance of work not done in accordance with the Contract Documents or relieve the Contractor of liability with respect to any express warranties or responsibility for faulty materials or workmanship.

PART 2 - PRODUCTS

PART 3 - EXECUTION

PART 4 - MEASUREMENT AND PAYMENT

Not Used.

END OF SECTION

SECTION 02221

DEMOLITION

PART 2 - GENERAL

2.1 DESCRIPTION OF WORK

- A. Work Included: This Section specifies the following items:
 - 1. Demolition, selective demolition and removal of site improvements.
 - 2. Removing below-grade construction.
 - 3. Disconnecting, capping or sealing and removing site utilities.
 - 4. Removing of retired signal equipment and instrument houses
 - 5. Salvaging items for reuse by the Authority.
 - 6. Removal of track material and its disposition
- B. Related Work: The following items are not included in this Section and will be performed under the designated Sections:
 - 1. Section 02852 **Grade Crossings**

2.2 DEFINITIONS

- A. Demolish: Completely remove and legally dispose of off-site.
- B. Salvage: Carefully detach from existing construction, in a manner to prevent damage, and deliver to Authority ready for reuse. Include fasteners or brackets needed for reattachment elsewhere.
- C. Hazardous Material: include but is not limited to asbestos and materials regulated under TSCA, RCRA (310CMR 30.00) and the Massachusetts Contingency Plan (MCP) (310 CMR 40.00) and building construction material defined by OSHA. Where applicable, consideration should be given to MSDS in determining if a material could be potentially hazardous.

2.3 MATERIALS OWNERSHIP

- A. Unless otherwise indicated, demolition waste becomes property of Contractor.
- B. Historic items, relics, antiques, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, and other items of interest or value to Authority that may be uncovered during demolition remain the property of Authority.
 - 1. Carefully salvage in a manner to prevent damage and promptly return to Authority.
- C. All turnouts, crossovers, rail and other track materials shall be designated as salvage material and delivered to the Authority
- D. All timber ties and switch timber removed shall be removed from the Authority's property and disposed

2.4 SUBMITTALS

- A. Proposed Protection Measures: Submit informational report in accordance with OSHA Part 1926 procedures, including drawings, that indicates the measures proposed for protecting individuals and property, for environmental protection, for dust control and for noise control. Indicate proposed locations and construction of barriers.
 - 1. Adjacent Buildings and Structures: Detail special measures proposed to protect adjacent buildings and structures to remain.
 - 2. Adjacent trackwork and systems equipment: Detail special measures proposed to protect adjacent trackwork and systems equipment to remain.
- B. Provide detailed sequence of demolition work, with starting and ending dates for each activity.
- C. Provide schedule of temporary interruption of utility services.
- D. Provide details for shutoff and capping or re-routing of utility services.
- E. Inventory: Submit a list of items to be removed and salvaged and deliver to Authority prior to start of demolition.
- F. Hazardous material remediation plan. Included in the plan are landfill records indicating receipt and acceptance of hazardous wastes by a landfill facility licensed to accept hazardous wastes.
- G. Results of Professional Engineer's survey required by Article 3.1D.
- H. All submittals shall be approved before work may proceed.

2.5 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.
- B. Standards: Comply with ANSI A10.6 and NFPA 241.
- C. Prepare a hazardous material remediation plan and submit to Authority for approval.
- D. Predemolition Conference: Conduct conference at Project site to review methods and procedures related to building demolition including, but not limited to, the following:
 - 1. Review of hazardous material remediation plan.
 - 2. Inspect and discuss condition of construction to be demolished.
 - 3. Review structural load limitations of existing structures.
 - 4. Review and finalize building demolition schedule and verify availability of demolition personnel, equipment, and facilities needed to make progress and avoid delays.
 - 5. Review and finalize protection requirements.
 - 6. Review procedures for noise control and dust control.
 - 7. Review procedures for protection of adjacent buildings.
 - 8. Review items to be salvaged and returned to Authority.

2.6 PROJECT CONDITIONS

- A. Signal Instrument Houses and cases to be demolished will be vacated and their use discontinued before start of the Work.
- B. On-site storage or sale of removed items or materials is not permitted.
- C. Construction Access and Staging
 - 1. Special attention shall be given to sequence demolition staging work so the MBTA Commuter Rail operations are not affected with respect to safety, operation and schedule.
 - 2. All materials removed as part of this demolition shall become the property of the Contractor and are to be disposed of properly according to applicable local, State and Federal regulations, unless otherwise specified by the Engineer.

2.7 COORDINATION

- A. Arrange demolition schedule so as not to interfere with Authority's operations and operations of adjacent occupied buildings.
- B. Demolition shall proceed in sections. The demolition work must be performed in conjunction with the approved sequence of construction plans.
- C. A minimum of one track must be in operation at all times. This track will be active during all demolition activities. The contractor must take steps to ensure that his operations will not impact rail service.

PART 3 - PRODUCTS (Not Used)

PART 4 - EXECUTION

4.1 EXAMINATION

- A. Verify that utilities have been disconnected and capped before starting demolition operations.
- B. Review Project Record Documents of existing construction provided by Authority. Authority does not guarantee that existing conditions are same as those indicated in Project Record Documents.
- C. Inventory and record the condition of items to be removed and salvaged. Provide photographs or video of conditions that might be misconstrued as damage caused by salvage operations.

4.2 PREPARATION

- A. Existing Utilities: Locate, identify, disconnect, and seal or cap off indicated utilities serving buildings and structures to be demolished.
 - 1. Arrange to shut off indicated utilities with utility companies.

2. If removal, relocation, or abandonment of utility services will affect adjacent occupied buildings, then provide temporary utilities that bypass buildings and structures to be demolished and that maintain continuity of service to other buildings and structures.
 3. Cut off pipe or conduit a minimum of 24 inches below grade. Cap, valve, or plug and seal remaining portion of pipe or conduit after bypassing according to requirements of authorities having jurisdiction.
- B. Existing Utilities: Refer to Contract Documents for shutting off, disconnecting, removing, and sealing or capping utilities. Do not start demolition work until utility disconnecting and sealing have been completed and verified in writing.
- C. Temporary Shoring: Provide and maintain interior and exterior shoring, bracing, or structural support to preserve stability and prevent unexpected movement or collapse of construction being demolished.
1. Strengthen or add new supports when required during progress of demolition.
- D. Salvaged Items: Comply with the following:
1. Clean salvaged items of dirt and demolition debris.
 2. Pack or crate items after cleaning. Identify contents of containers.
 3. Store items in a secure area until delivery to Authority.
 4. Transport items to storage area designated by Authority.
 5. Protect items from damage during transport and storage.

4.3 PROTECTION

- A. Existing Facilities: Protect adjacent walkways, loading docks, building entries, and other building facilities during demolition operations. Maintain exits from existing buildings.
- B. Existing Utilities: Maintain utility services to remain and protect from damage during demolition operations.
1. Do not interrupt existing utilities serving adjacent occupied or operating facilities unless authorized in writing by Authority and authorities having jurisdiction.
 2. Provide temporary services during interruptions to existing utilities, as acceptable to Authority and authorities having jurisdiction.
 - a. Provide at least 72 hours notice to occupants of affected buildings if shutdown of service is required during changeover.
- C. Temporary Protection: Erect temporary protection, such as walks, fences, railings, canopies, and covered passageways, where required by authorities having jurisdiction and as indicated. Comply with requirements in Division 1 and 1A.
1. Protect adjacent buildings and facilities from damage due to demolition activities.
 2. Protect existing site improvements, appurtenances, and landscaping to remain.
 3. Erect a plainly visible fence around drip line of individual trees or around perimeter drip line of groups of trees to remain.
 4. Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.

- D. Remove temporary barriers and protections where hazards no longer exist. Where open excavations or other hazardous conditions remain, leave temporary barriers and protections in place.

4.4 DEMOLITION, GENERAL

- A. General: Demolish indicated site improvements completely. Use methods required to complete the Work within limitations of governing regulations and as follows:
 - 1. Do not use cutting torches until work area is cleared of flammable materials. Maintain portable fire-suppression devices during flame-cutting operations.
 - 2. Maintain fire watch during and for at least four hours after flame cutting operations.
 - 3. Maintain adequate ventilation when using cutting torches.
- B. Engineering Surveys: During demolition, perform surveys to detect hazards that may result from demolition activities.
- C. Site Access and Temporary Controls: Conduct demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
 - 1. Do not close or obstruct streets, walks, walkways, or other adjacent occupied or used facilities without permission from Authority and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.
 - 2. Use water mist and other suitable methods to limit spread of dust and dirt. Comply with governing environmental-protection regulations. Do not use water when it may damage adjacent construction or create hazardous or objectionable conditions, such as ice, flooding, and pollution.
- D. Explosives: Use of explosives is not permitted.

4.5 DEMOLITION BY MECHANICAL MEANS

- A. Remove debris from elevated portions of the work by chute, hoist, or other device that will convey debris to grade level in a controlled descent.
 - 1. Remove structural framing members and lower to ground by method suitable to minimize ground impact and dust generation.
- B. Salvage: Items to be salvaged are indicated on Drawings.
- C. Below-Grade Construction: Demolish foundation walls and other below-grade construction that are within footprint of new construction and extending 5 feet outside footprint indicated for new construction. Abandon below-grade construction outside this area.
 - 1. Remove below-grade construction, including basements, foundation walls, and footings, to at least depths indicated.
- D. Existing Utilities: Abandon existing utilities and below-grade utility structures. Cut utilities flush with grade unless indicated otherwise.

4.6 REMOVAL

- A. Remove entirely existing miscellaneous structures and site improvements that interfere with construction within the limits described or as designated by the Engineer. Remove walls and masonry construction to a minimum depth of two feet below existing ground level in areas where such items do not interfere with construction.
- B. Remove all material generated by removal operations and other related operations off the site and dispose of in compliance with all applicable laws and regulations.
- C. All removal and disposal must be done in accordance with applicable state and federal laws.
- D. Any element to be removed that performs a safety function – such as fencing and signage – shall not be removed until its safety function is no longer necessary or has been replaced.

4.7 SALVAGE

- A. Salvage indicated material or material determined by the Engineer to be suitable for reuse, including: grates, frames, other metal castings and miscellaneous parts of inlets and manholes; hydrants, fire alarm posts and boxes; metal light poles; sound pipe and valves; metal fencing; guard rail; highway and street signs and posts shall be delivered to the MBTA.
- B. Protect metallic coatings on salvaged items. Remove adhering concrete from salvaged items where required for disposal or directed by the Engineer.
- C. Repair, or replace with new material, salvaged material damaged or destroyed due to the Contractor's negligence.
- D. All items designated as "remove" and not relocated as part of this project, and determined to be in salvageable condition by the engineer, shall be delivered to the MBTA Railroad Operations material yard in Charlestown, MA, unless otherwise directed by the Engineer. No delivery will be greater than 60 miles, one way. Such delivery of materials must be coordinated with the Engineer prior to delivery.

4.8 SITE RESTORATION

- A. Below-Grade Areas: Rough grade below-grade areas ready for further excavation or new construction.
- B. Site Grading: Uniformly rough grade area of demolished construction to a smooth surface, free from irregular surface changes. Provide a smooth transition between adjacent existing grades and new grades.

4.9 REPAIRS

- A. Promptly repair damage to adjacent buildings, utilities, fences, or other structures caused by demolition operations.

4.10 DISPOSAL OF DEMOLISHED MATERIALS

- A. Remove demolition waste materials from Project site and legally dispose of them in an EPA-approved landfill acceptable to authorities having jurisdiction.
 - 1. Do not allow demolished materials to accumulate on-site.
 - 2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
- B. Do not burn demolished materials.

4.11 CLEANING

- A. Clean adjacent structures and improvements of dust, dirt, and debris caused by demolition operations. Return adjacent areas to condition existing before demolition operations began.

4.12 TRACK AND TURNOUT REMOVAL AND DISPOSITION OF MATERIALS

- A. Prior to track construction the existing track and turnouts shall be dismantled and removed to the limits shown on the Contract Drawings.
- B. Rail, joint bars and tie plates shall be salvaged and returned to the Authority as specified in paragraph G.
- C. Track bolts, nuts, washers, spikes, anchors and lags shall become the property of the Contractor and shall be disposed of off of the Authority's property.
- D. Track and turnout dismantling shall be done using equipment and procedures that will not damage salvaged material or make it unfit for future use. If a torch is used to remove bolts from joints care must be taken so as not to damage joint bar.
- E. All salvaged turnout material shall be packaged as a unit and delivered to designated Authority material yard(s) in Somerville or elsewhere within 50 miles of the Project, and shall be unloaded and stockpiled as directed by yard personnel.
- F. All salvaged rail and other track materials shall be delivered to designated Authority material yard(s) in Somerville or elsewhere within 50 miles of the Project. Materials shall be separated, not mixed together, by class, type and weight and stockpiled as directed by yard personnel.
- G. Crossties and Switch Timber - All existing crossties and switch timber removed shall become the property of the Contractor, removed from the ROW and disposed of as indicated in paragraphs I through M below.
- H. Disposal shall be accomplished through incineration of ties, tie butts and switch timber and bridge timber at an approved facility.
- I. The processing and disposal facility/facilities shall be fully licensed and permitted for handling, processing, storage and incineration of treated wood waste.
- J. Bottom ash, fly ash, and other by-product residues from the combustion process shall be disposed of at a fully licensed land fill.

- K. Identified combustion facilities must be approved by the Authority's Project Manager prior to the commencement of burning of disposed ties and timbers.
- L. The Contractor shall provide the Engineer with a copy of a certified weight slip for each quantity shipped, unloaded, and properly disposed of at the licensed facility.

PART 5 - MEASUREMENT AND PAYMENT

5.1 GENERAL

- A. No separate measurement will be made for demolition but all costs in connection therewith shall be included in the Lump Sum price for Item No. 490.01 – Railroad Grade Crossing Reconstruction, except as otherwise noted. All preparation and incidental work necessary to accomplish the removals will be considered incidental to the Lump Sum price.

END OF SECTION

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SECTION 02852
GRADE CROSSINGS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. This section specifies removal of existing highway grade crossings and construction of new public grade crossings as shown on Contract Drawings.
- B. Grade crossings surfaces shall be rubber rail seal and bituminous in accordance with the Contract Drawings.
- C. Prior to removal of existing highway grade crossings and installation of new grade crossings the Contractor shall identify and avoid all underground utilities.
- D. Prior to the removal of existing and construction of new grade crossings the Contractor shall contact DIG-SAFE. The Contractor shall also notify any fiber optic companies operating within the project limits.
- E. Related Work: The following items are not included in this Section and will be performed under the designated Sections:
 - 1. Section 02860 – GEOTEXTILE FABRIC

1.2 SUBMITTALS

- A. Submit the following to the Engineer for approval at least four weeks before the work of this Section is to begin:
 - 1. Shop Drawings:
 - a. Submit the type of crossing system and the manufacturer's literature including drawings and a detailed installation specification.
- B. Submit detour plans approved by City of Chelsea.
- C. Submit an overall schedule and activities for the crossing reconstruction indicating a completion time within the outage agreed to with both the Authority and the jurisdictional authority.
- D. All submittals will be reviewed for general conformance with the intent of the contract documents. This review will not relieve the Contractor of final responsibility for the means, methods, procedure and sequences to be utilized.

1.3 QUALITY CONTROL

- A. The following Codes, Regulations, Referenced Standards and Specifications apply to work included in this Section:
 - 1. Codes and regulations of the jurisdictional authorities.

shall be defined as Cable line Plans. These plans shall show the single line track configuration and identify each track, signal, and related items of signal apparatus. These drawings shall identify conduit, duct or raceway location and shall indicate the installed cables. Existing line plan can be used. Overwrite the line plan with the actual cable routing.

- D. Drawings which indicate point-to-point cable runs and identify cable make-up and conductor wire size shall be defined as Track and Cable Plans. These plans shall show the double line track configuration and identify each track circuit, signal, and related items of signal apparatus. These drawings shall identify conduit, duct or raceway location and shall indicate the required sizes of all such conduit, duct work, and cables. Existing track and cable can be used. Overwrite the existing track and cable or routing plan to show actual conduit placement and cable routing.
- E. Drawings, to scale showing the location of duct banks including manholes and hand holes and locations of the conduit ends installed for cable under bridges, over, bridges, culverts, rock cuts and other obstacles and as shown on the Contract Drawings shall be known as Site Plans and Conduit/Cable Layout (Scaled). These plans shall identify the actual method of attachment, (hanging), fastening, suspending or installation of conduit, duct or raceway location and shall indicate the required sizes of all such conduit, duct work, fastening materials and cables.
- F. Drawings showing any temporary work required, but will not remain as part of the completed work shall be known as TEMPORARY PLANS and shall be entitled to define the purpose served.

PART 2 - PRODUCTS

2.1 MATERIAL

- A. Final As-Built drawings shall be:
 - 1. Electronic copy CAD and **searchable** PDF and ten (10) hard copy of the as-built contract drawings
 - 2. A paper copy of as-built drawing(s) shall be left in the field at the appropriate signal housing.

PART 3 - EXECUTION

3.1 PLAN BOOKS FOR INSTALLATION

- A. The Contractor shall maintain a complete set of up-to-date as-built book of plans for each location of this Contract at the specific location. At no time shall a location be left without a complete set of up-to-date plans.
- B. The Contractor shall maintain an additional; complete set of up-to-date book of plans for this Contract at his on-site headquarter and another at the Engineers project office.
- C. The location shall be clearly marked on the final As-Built drawings.
- D. During the progress of work, prints shall be made showing the latest revision of work completed and put in-service.
- E. The Contractor shall provide the Engineer an electronic as built copy of the plans no later than 30 days

after placing any portion of the work shown on the approved plans in-service.

- F. When recording work in progress the Contractor shall use an “X” for removal and “O” for additions symbols. An orange pencil shall be used to show the conditions are acceptable, brown for verified tags, red for changes to remove and green for changes to be added.

PART 4 - MEASUREMENT AND PAYMENT

4.1 GENERAL

- A. No separate measurement will be made for drawings but all costs in connection therewith shall be included in the Lump Sum price for Item No. 490.01 - Railroad Grade Crossing Reconstruction except as otherwise noted. All preparation and incidental work necessary to accomplish the drawings will be considered incidental to the Lump Sum price.

END OF SECTION

SECTION 16806

EXCAVATION

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This Section specifies the furnishing of all labor, material, and equipment required for safe excavation, trenching, backfilling, tamping and grading for cable, conduits, footings, concrete pads, troughs, signal houses and foundations for signal cases, junction cases, signals, and other facilities at various locations as indicated herein and on the Contract Drawings.
- B. Rock excavation, if encountered, shall be included in this Section and is defined as the removal and disposal of materials in-place that cannot be loosened or broken down by ripping, or by the use of modern construction earth excavating equipment.
- C. Materials which require special rock excavation equipment, or blasting for removal, such as boulders measuring one-half cubic yard or more, and all solid rock, masonry, and concrete pavements requiring hand power tools for fragmenting prior to removal shall also be included in this Section.
- D. Sheet piling, shoring, and de-watering of excavated areas and trenches shall be included as necessary for the work described herein.
- E. Backfill materials shall consist of suitable on-site earth excavation; crushed stone, sand, and gravel borrow as specified herein.
- F. The Contractor shall not excavate under or near track so as to adversely affect its integrity without prior approval of construction method and with the Engineer's approval.
- G. Comply fully with the requirements of the **MassDOT Highway Division Standard Specifications for Highways and Bridges**.

1.2 QUALITY ASSURANCE

- A. Backfill materials specified shall be approved by the Engineer prior to placement. The Contractor shall arrange for material analysis and all certifications as directed by the Engineer, at no additional cost to the Contract.
- B. Any voids shall be backfilled again until stabilized.
- C. Backfill in a manner to prevent washouts.

1.3 SUBMITTALS

- A. A description of materials and methods of installation to be furnished under this Contract including, but not limited to, types of cable trough systems, conduits, hand holes, etc.
- B. Certified compaction test reports for material required to be compacted, as specified in various Sections of these and the MBTA Standard Specifications. The percent compaction shall be in accordance with applicable Sections of these Specifications.

- C. The type of protective covering to be used to prevent contamination of existing ballast during excavation.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Backfill materials delivered to the site and excavated materials suitable for backfill shall be stored in areas designated by the Engineer in neat piles which will not interfere with railroad system operating traffic movements or work being performed by others. Surplus excavated materials not required for backfill shall be removed from the site for disposal as soon as possible.

1.5 JOB CONDITIONS

- A. Sheeting and shoring of trenches shall be in conformance with applicable local and other governmental codes and regulations.
- B. Transportation of backfill materials and dust control on or near the work shall be in compliance with applicable environmental codes and regulations.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. General requirements pertaining to trenching and backfill materials are as follows:
1. On-site materials obtained from trench and other excavation, to be used as ordinary backfill under this Contract shall have physical characteristics of soils designated as group A-1, A-2-4 or A-3 under AASHTO M-145.
 2. Crushed stone base for foundations and replacement of excavated ballast shall be AREA size No. 5 having the following gradation:

<u>Size of Opening</u>	<u>Percent Passing by Weight</u>
1-1/2 inches	100
1 inch	90 - 100
3/4 inch	40 - 75
1/2 inch	15 - 35
3/8 inch	0 - 15
No. 4	0 - 5

3. Sand for cable bedding shall consist of clean, inert, hard, durable grains of quartz or other hard, durable rock, free from loam or clay, surface coatings, and deleterious materials. The allowable amount of material passing a No. 200 sieve as determined by AASHTO T11 shall not exceed ten percent by weight.
4. Gravel backfill shall consist of inert material that is hard, durable stone and coarse sand, free from

CONST. OF THE SILVERLINE GATEWAY BUSWY,BRT STAS&BRG REPLACEMENT(STEEL)BR.#C-09-
001 WASHINGTON AVE. OVER THE MBTA RAILROAD

ITEM NUMBER	QUANTITY	ITEM WITH UNIT BID PRICE WRITTEN IN WORDS	UNIT PRICE	AMOUNT
795.079	60	VIBURNUM - WITHEROD 18-24 INCH AT _____ EACH		
795.081	11	VIBURNUM - WITHEROD 24-30 INCH AT _____ EACH		
796.100	280	NEPETA 'WALKERS LOW' 1 GAL. AT _____ EACH		
796.455	536	SWITCH GRASS 2 GALLON AT _____ EACH		
796.715	380	BLACK EYED SUSAN 2 QUART AT _____ EACH		
796.725	450	CARDINAL FLOWER 2 QUART AT _____ EACH		
796.768	31	DAYLILY - 'RED HOT RETURNS' AT _____ EACH		
796.803	700	NEW ENGLAND ASTER 1 GALLON AT _____ EACH		
796.817	420	PURPLE CONEFLOWER 2 QUART AT _____ EACH		
796.900	604	BUTTERLY MILKWEED 2 QUART AT _____ EACH		

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AE ID: 49987

CHELSEA

CONST. OF THE SILVERLINE GATEWAY BUSWY,BRT STAS&BRG REPLACEMENT(STEEL)BR.#C-09-
001 WASHINGTON AVE. OVER THE MBTA RAILROAD

ITEM NUMBER	QUANTITY	ITEM WITH UNIT BID PRICE WRITTEN IN WORDS	UNIT PRICE	AMOUNT
796.950	320	GOLDENROD 1 GALLON AT _____ EACH		
801.42	300	4 INCH ELECTRICAL CONDUIT - TYPE NM (DOUBLE) AT _____ PER FOOT		
801.44	70	4 INCH ELECTRICAL CONDUIT - TYPE NM (4 BANK) AT _____ PER FOOT		
801.48	80	4 INCH ELECTRICAL CONDUIT - TYPE NM (8 BANK) AT _____ PER FOOT		
801.52	100	5 INCH ELECTRICAL CONDUIT - TYPE NM (DOUBLE) AT _____ PER FOOT		
801.56	120	5 INCH ELECTRICAL CONDUIT - TYPE NM (6 BANK) AT _____ PER FOOT		
801.58	70	5 INCH ELECTRICAL CONDUIT - TYPE NM (8 BANK) AT _____ PER FOOT		
804.3	10,000	3 INCH ELECTRICAL CONDUIT TYPE NM - PLASTIC -(UL) AT _____ PER FOOT		
804.4	1,000	4 INCH ELECTRICAL CONDUIT TYPE NM - PLASTIC -(UL) AT _____ PER FOOT		
806.4	160	4 INCH ELECTRICAL CONDUIT TYPE RM - GALVANIZED STEEL AT _____ PER FOOT		

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CONST. OF THE SILVERLINE GATEWAY BUSWY,BRT STAS&BRG REPLACEMENT(STEEL)BR.#C-09-001 WASHINGTON AVE. OVER THE MBTA RAILROAD

ITEM NUMBER	QUANTITY	ITEM WITH UNIT BID PRICE WRITTEN IN WORDS	UNIT PRICE	AMOUNT
806.41	400	4 INCH ELECTRICAL CONDUIT TYPR RM - SPLIT GALVANIZED STEEL AT _____ PER FOOT		
810.1	6,500	CONDUIT ENCASED IN CONCRETE AT _____ PER FOOT		
810.11	3,000	EXISTING CONDUIT ENCASED IN CONCRETE AT _____ PER FOOT		
811.22	90	ELECTRIC HANDHOLE - SD2.022 AT _____ EACH		
811.31	37	PULL BOX 12 X 12 INCHES - SD2.031 AT _____ EACH		
815.1	1	TRAFFIC CONTROL SIGNAL LOCATION NO. 1 AT _____ LUMP SUM		
815.2	1	TRAFFIC CONTROL SIGNAL LOCATION NO. 2 AT _____ LUMP SUM		
815.3	1	TRAFFIC CONTROL SIGNAL LOCATION NO. 3 AT _____ LUMP SUM		
815.4	1	TRAFFIC CONTROL SIGNAL LOCATION NO. 4 AT _____ LUMP SUM		
815.6	1	SIGNAL TIMING ADJUSTMENT FOR BROADWAY/CARY AVENUE AT _____ LUMP SUM		

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CONST. OF THE SILVERLINE GATEWAY BUSWY,BRT STAS&BRG REPLACEMENT(STEEL)BR.#C-09-001 WASHINGTON AVE. OVER THE MBTA RAILROAD

ITEM NUMBER	QUANTITY	ITEM WITH UNIT BID PRICE WRITTEN IN WORDS	UNIT PRICE	AMOUNT
815.7	1	EMERGENCY PRE-EMPTION INSTALLATION@BROADWAY/CARY AVE INT. AT _____ LUMP SUM		
815.8	1	INSTALL TEMP FULL VEHICLE SIGNAL CONTROL@WASHINGTON/CARY AT _____ LUMP SUM		
820.10	1	HIGHWAY LIGHTING - ROADWAY AT _____ LUMP SUM		
823.70	6	HIGHWAY LIGHTING POLE AND LUMINAIRE REMOVED AND RESET AT _____ EACH		
832.	850	WARNING-REGULATORY AND ROUTE MARKER - ALUM. PANEL (TYPE A) AT _____ PER SQUARE FOOT		
833.5	40	DEMOUNTABLE REFLECTORIZED DELINEATOR - GUARD RAIL AT _____ EACH		
833.7	8	DELINEATION FOR GUARD RAIL TERMINI AT _____ EACH		
847.1	150	SIGN SUP (N/GUIDE)+RTE MKR W/1 BRKWAY POST ASSEMBLY - STEEL AT _____ EACH		
850.	1	CONSTRUCTION NOISE CONTROL AT _____ LUMP SUM		

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